MECHANICAL ENGINEERING

February 1957

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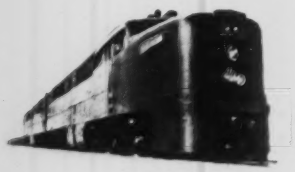
ASME Spring Meeting • Birmingham, Ala. • April 8-10, 1957

SINCE 1888 ALCO Has Said: "Steam Supply by B&W"



Back in 1888, when the *American Type* locomotive was setting speed records on passenger runs, B&W sold its first boiler to Schenectady Locomotive Works, predecessor of ALCO Products, Inc., to serve the plant.

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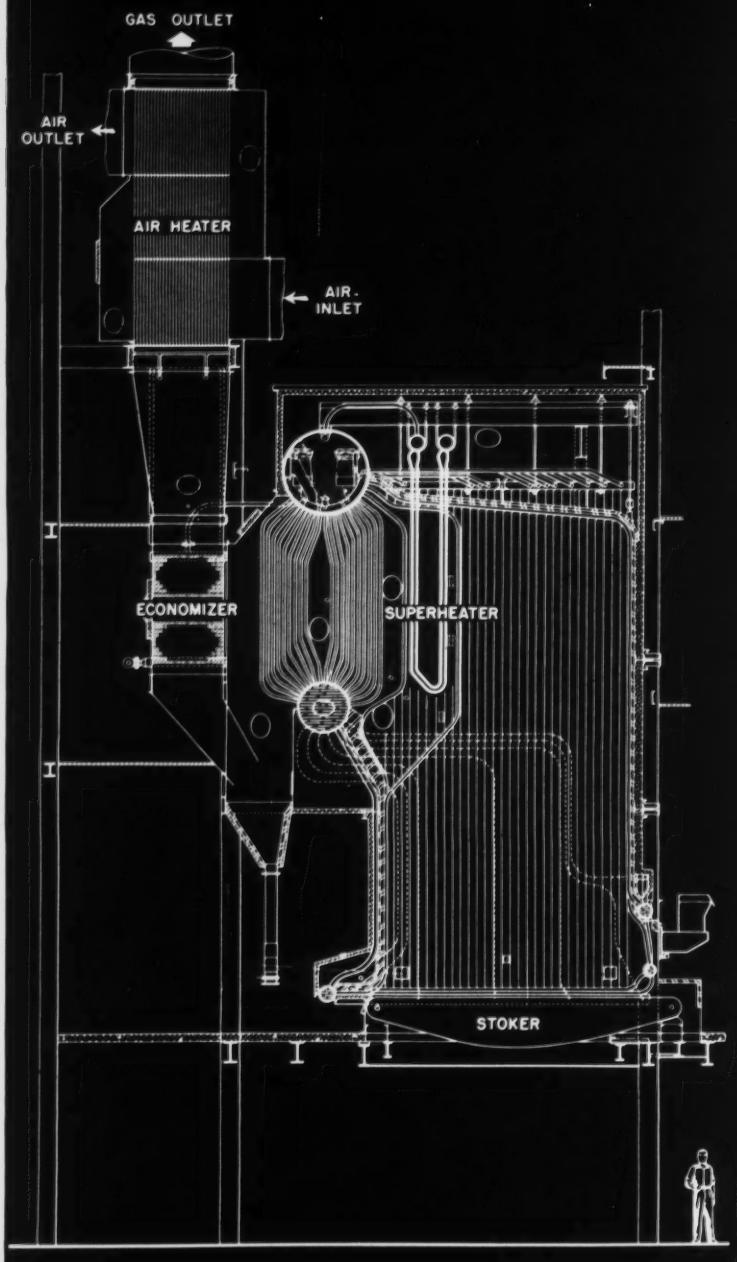

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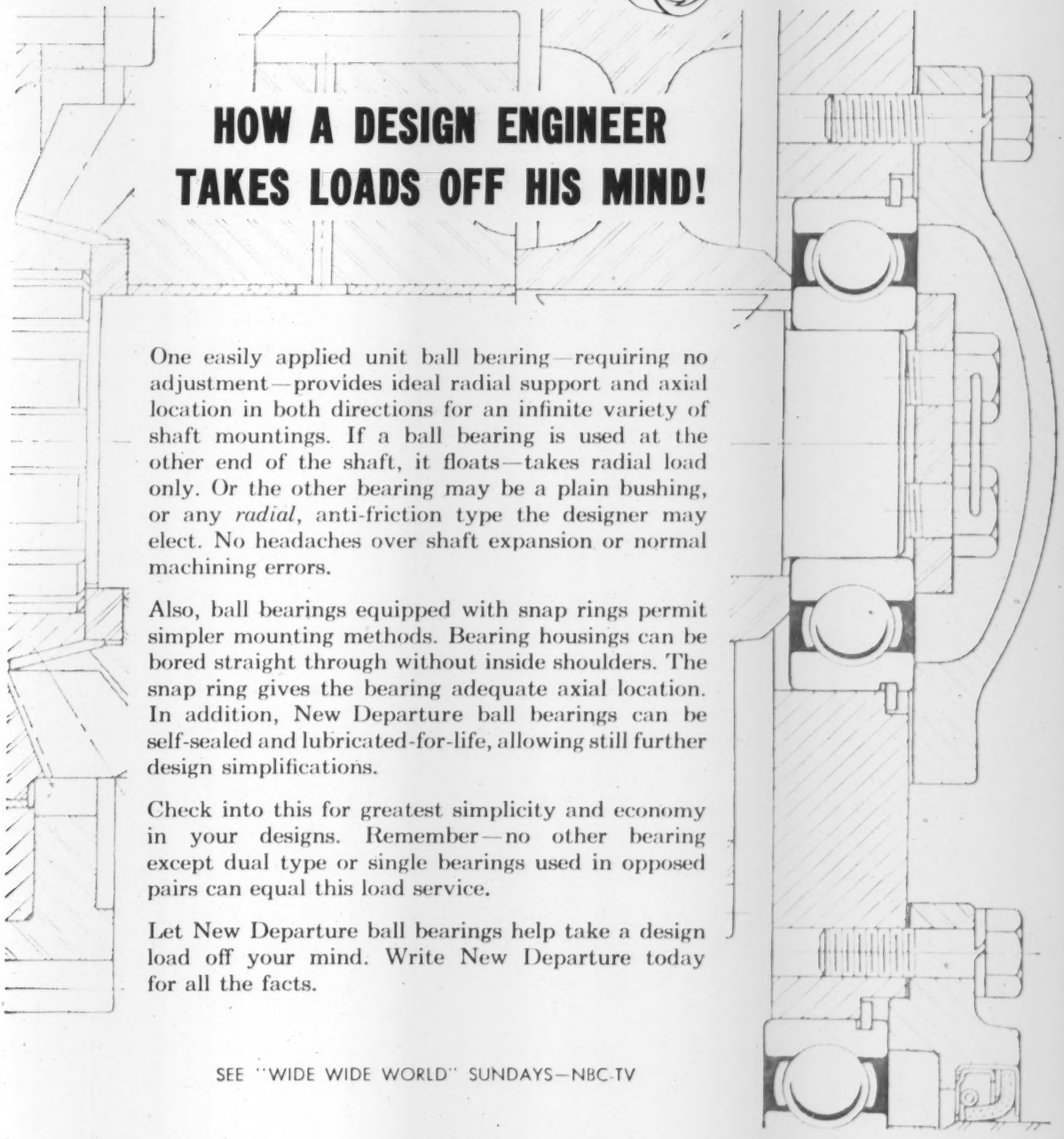
FACTS

about

NEW DEPARTURE BALL BEARINGS



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NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.

MECHANICAL ENGINEERING, February, 1957, Vol. 79, No. 2. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price to members $3.50 annually, single copy 50¢; to nonmembers $7.00 annually, single copy 75¢. Add $1.50 postage to all countries outside the United States, Canada, and the Pan-American Union. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Member of the Audit Bureau of Circulations.

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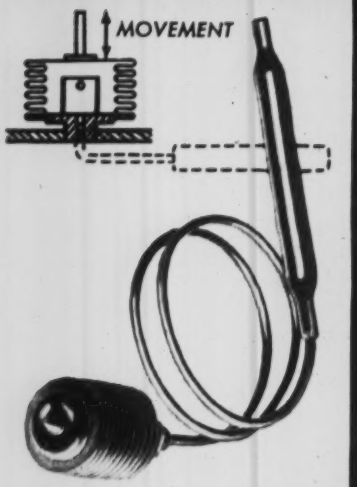

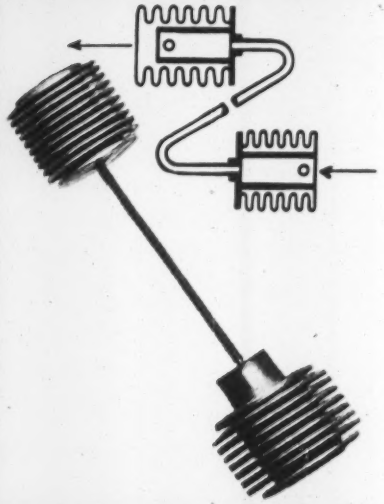

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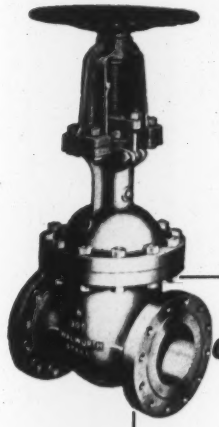
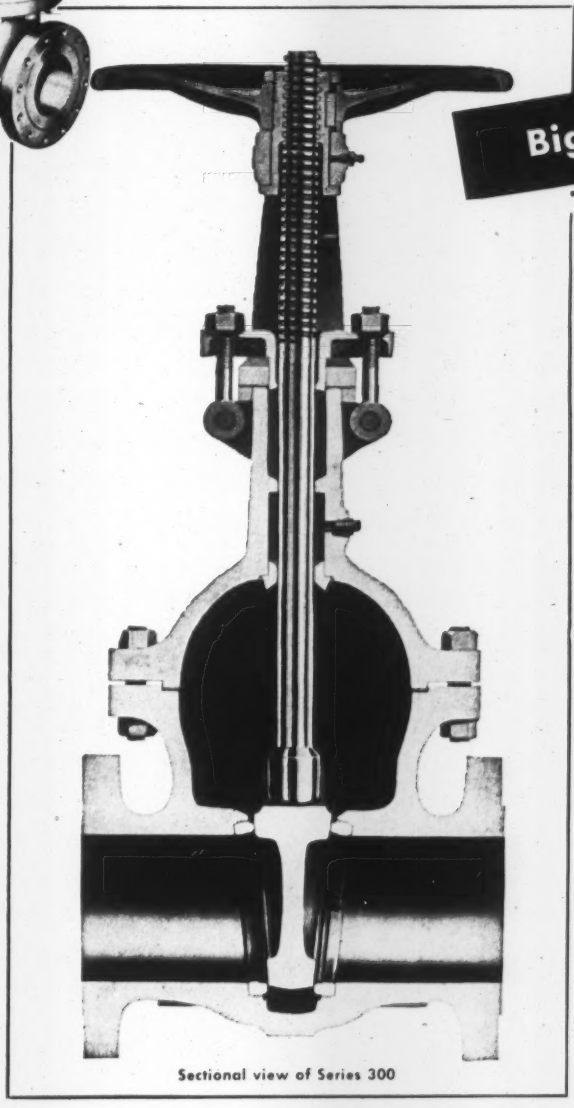
Series 150 and 300

Wedge Gate — Outside Screw and Yoke





Sectional view of Series 300

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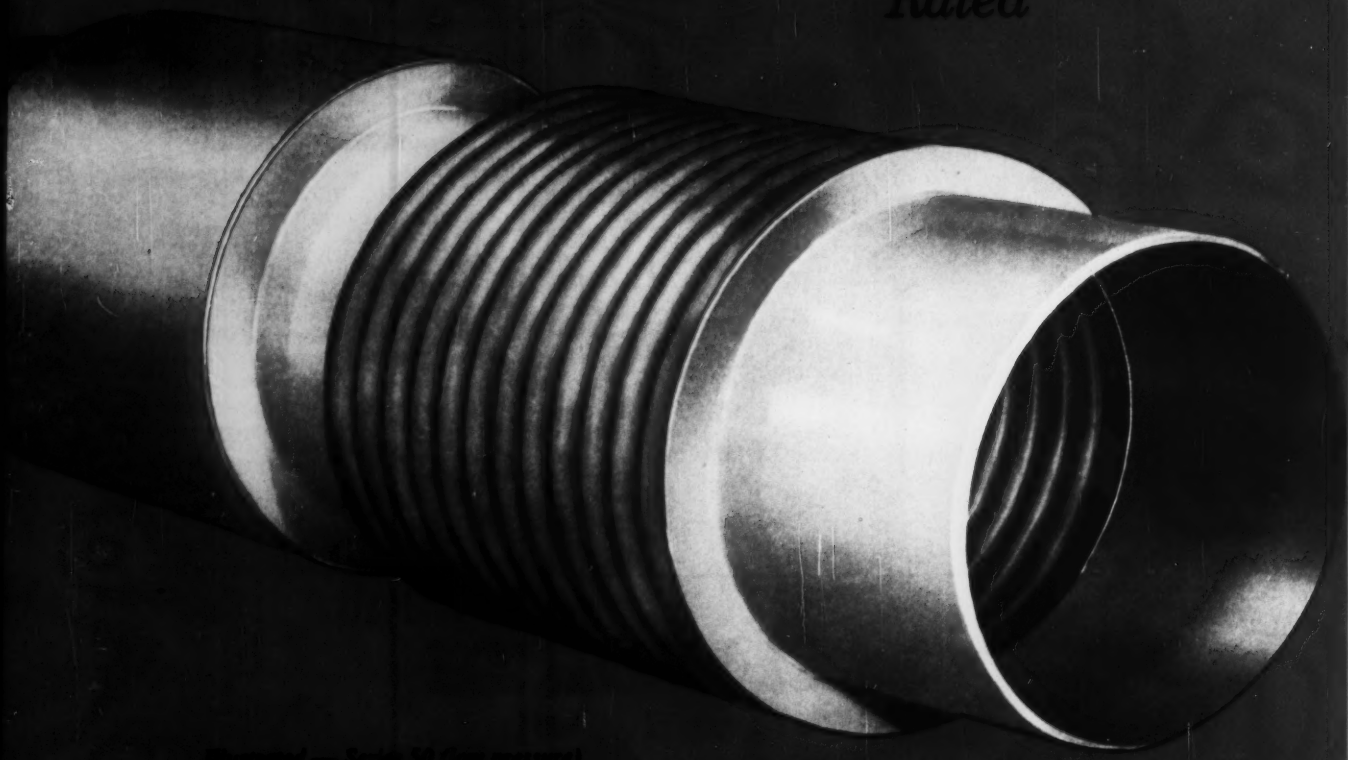

Illustrated — Series 50 (low pressure) S-R Double Joint with welding ends. Cover removed from one bellows.

most experienced manufacturer

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And there are other important features, too . . . size for size, Badger S-R Joints weigh up to 50% less than conventional types . . . new ring design reduces joint diameter . . . a complete line of accessories — including covers and liners — are available . . . standard models in stainless, monel and inconel, special types in any workable alloy.

Cutaway view Series 150 (intermediate pressure) S-R Joint

New corrugation and ring designs produce better equalization, "all-curve" flexing

Series 50 (low pressure) S-R Expansion Joints

The radically different Curvilinear Corrugations used in Badger S-R Expansion Joints were developed by the Badger Research Department. As shown in the cross-section of a Series 50 Joint (left), the design produces more uniform movement per corrugation and flexing to a natural "all-curve" shape, which results in lower stresses and therefore increased life. (White line in diagram shows the efficient "all-curve" shape the corrugations *naturally* assume under operating pressures.)

Series 150 (intermediate pressure) S-R Expansion Joints

Series 150 S-R Joints feature Curvilinear Corrugations and, because they are used at higher pressures, also have tubular Reinforcing Rings. A significant engineering improvement, these new rings make metal-to-metal contact only in the "valley" of each corrugation yet allow natural "all-curve" flexing (white line) when the pipeline is subjected to pressure. The tubular shape of the rings also permits greater effective flexing height and therefore contributes to longer joint life.

Learn more about ways S-R Joints can be of advantage to you . . .

New illustrated brochure describes them in detail — mail coupon for your free copy today.

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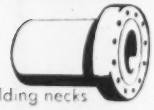

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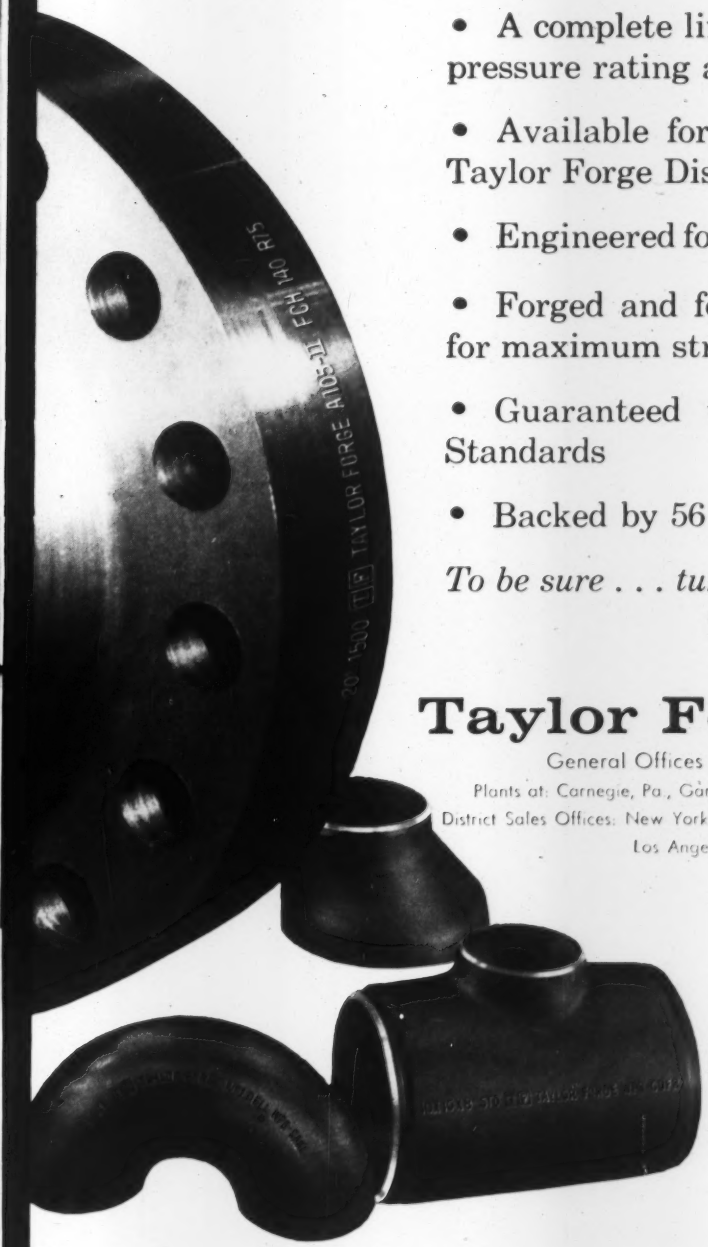

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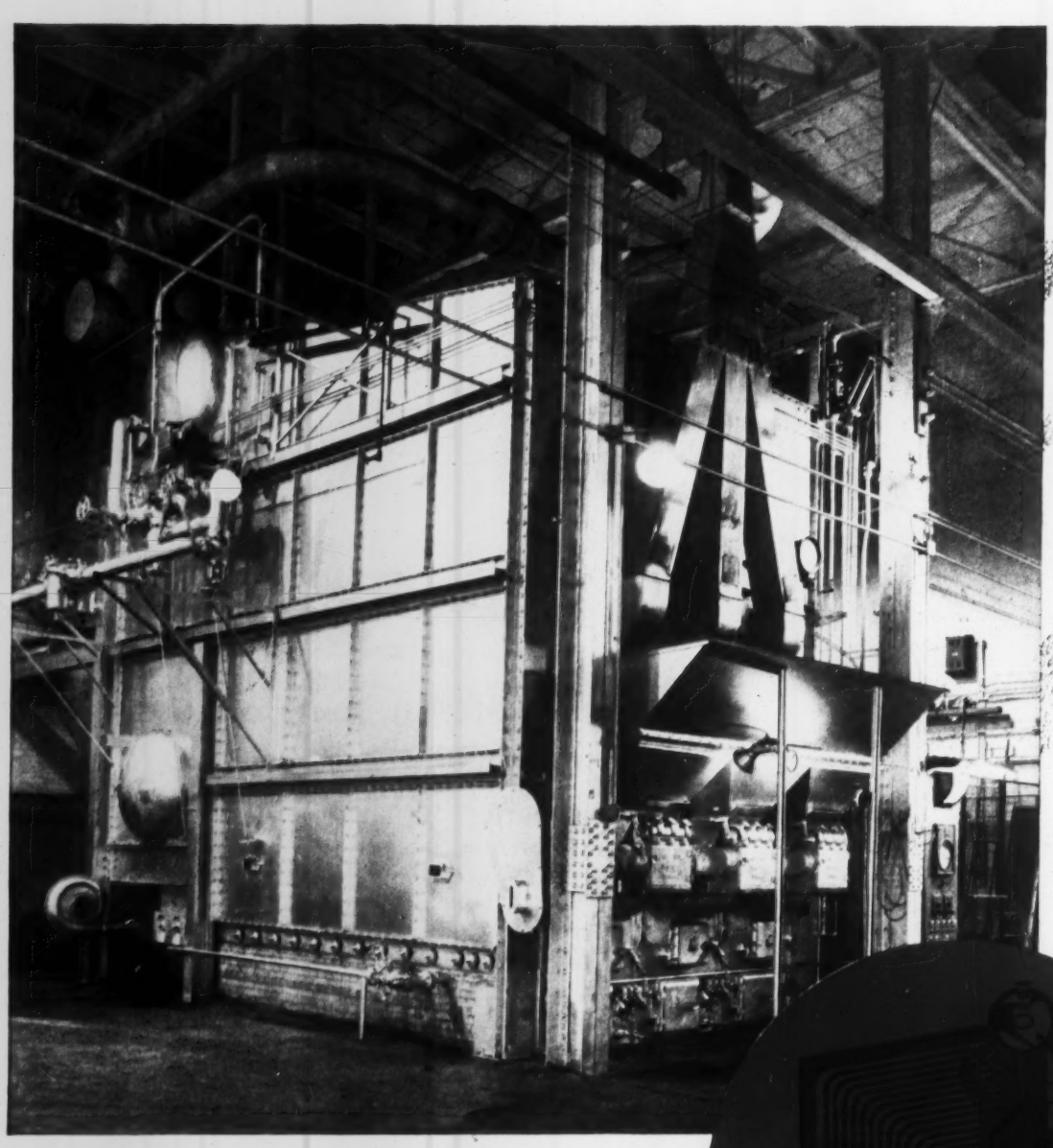
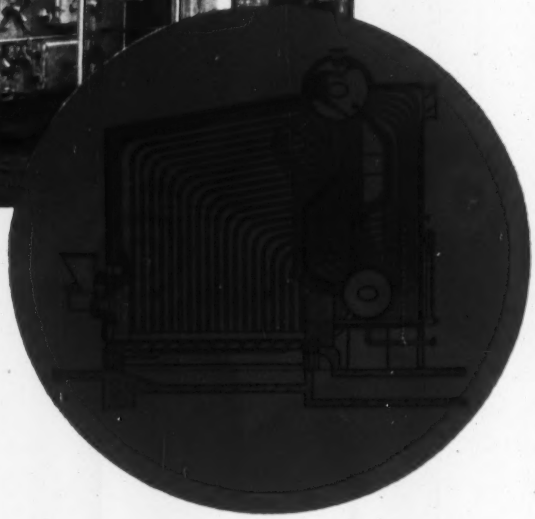


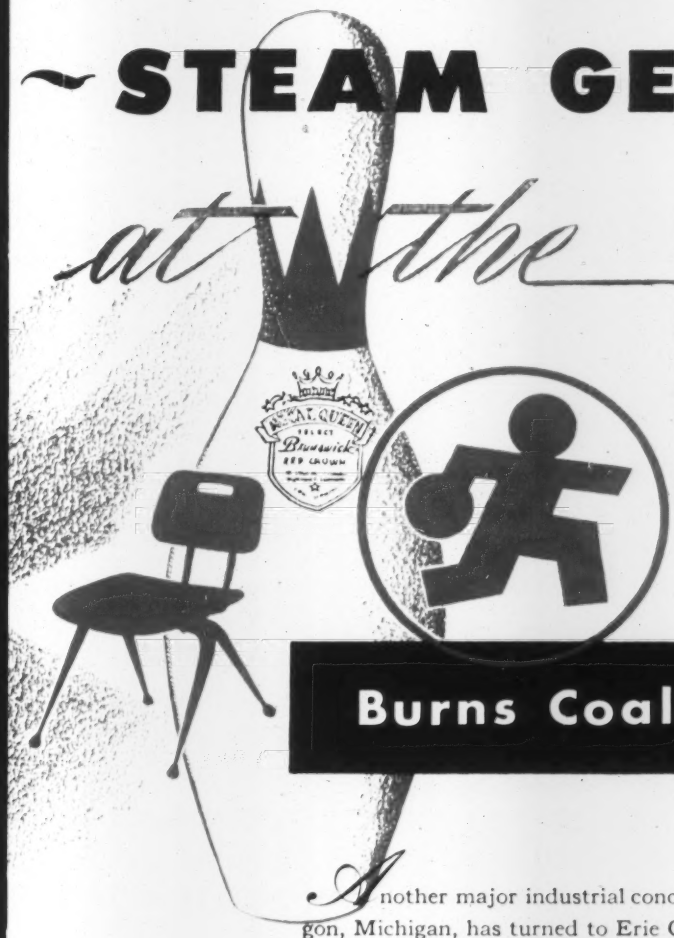


Data

Boiler	Erie City 4 VC
Capacity	35,000 lbs./hr.
Operating Pressure	250 lbs.
Stoker	Erie City Dump Grate Spreader

~STEAM GENERATOR

at the BRUNSWICK-BALKE-COLLENDER COMPANY



Burns Coal + Wood Waste...

Another major industrial concern, Brunswick-Balke-Collender Company of Muskegon, Michigan, has turned to Erie City Iron Works to satisfy its steam needs. Brunswick required a 35,000 lbs./hr. boiler, fired with coal, and having a properly designed furnace to burn their constant accumulation of wood waste. To satisfy these requirements, Erie City engineers used a standard 4-VC Boiler and a triple feeder dump grate spreader stoker.

The furnace was specifically designed to burn the coal that was most economically available and with sufficient furnace volume to burn the wood waste. The boiler proper is designed with drainable baffles and reinjection system to return any unburned particles of wood or coal to the furnace. The VC unit was selected for its compact design and low installation cost. The complete water cooled furnace eliminates the necessity of heavy refractory walls and thereby reduces maintenance costs.

This installation at Brunswick-Balke-Collender is another fine example of how Erie City engineers can adapt standard products to suit particular requirements.

For additional information on Erie City VC boilers or spreader stokers, contact your local Erie City Agent or write for bulletins VC 4B and SB 424B.

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You can depend on Erie City for sound engineering

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THIRD OF A SERIES

Why reliability engineering is not enough

There's more to reliability than meets the eye . . . a thousand inspectors cannot put reliability into an item that is inherently weak in engineering or production design . . . highest reliability in a component is obtained only when the manufacturer is aware of the problems in obtaining reliability . . . plus providing a proper climate in which employees are motivated by pride in product to surpass specifications.

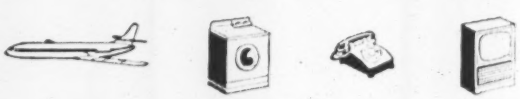
In our humble opinion, the building of reliability into a product requires an alert *awareness* of the many, many facets of the problem. We'd like to submit these . . .

- ***"Integrity of intent" on the part of the manufacturer to meet the problems . . . coupled with provision of a proper climate for the carrying out of reliability objectives***
- ***Financial ability to take the necessary steps***
- ***Modern manufacturing equipment and methods***
- ***Plant capacity and flexibility***
- ***Design and engineering know-how that recognizes end-use requirements and environmental conditions***
- ***Careful employee selection and training***
- ***Long-range master planning***
- ***In-plant industrial and production engineering***
- ***Research, testing, development laboratory activities, including complete testing of prototype to end-use requirements***
- ***Continuous reliability assurance testing during the manufacturing operation, and institution of required corrective action***
- ***Collection, in the field, of failure data, analysis, and corrective action***
- ***All of these facets in depth***

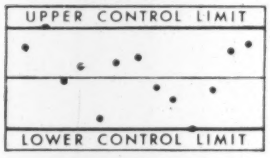
Important as all of these are, the most important is the provision of proper climate, in the form of spirit and attitude of all personnel in pride of product, to carry out reliability objectives. In preceding articles in this series we've touched on some of the more technical aspects of reliability engineering. The manufacturer must naturally have an awareness of the problem, the integrity of intent to turn out the best product it can for a particular market or application, the financial ability to establish a Reliability program, the management ability to install it, the necessary manufacturing equipment and engineering organization to carry it out. But *all of these are not enough, if they are not instituted in a climate where an attitude will prevail that makes such things effective.*

The manufacturer's integrity must necessarily be carried out, also, in the design, in manufacturing, and in finally warranting the product created . . . but, again, with every man and woman in the organization trying to meet or exceed the standards that have been created. This latter aspect we call "pride of product" on the part of the people who are producing it. And such pride must exist not only for the final product but for each part of that product, and in each step in the process. There is also an added dividend to reliability; the reputation of the product will cause the user to handle it with the same pride and care as was put into its manufacture.

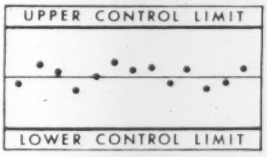
It is interesting that people who are proud of a product, and enjoy what they are doing, can keep closer tolerances on the parts they work with and produce than those who are merely working for their pay. An assembler, who's proud of the product turned out, sees questionable components and avoids putting them into the assembly, while a disinterested person leaves them for "inspection" to catch. It is interesting in this connection, too, that some of the finest watch



parts made in Switzerland are produced in little shops where modern quality control techniques are unheard of . . . produced by a craftsman whose major technique is pride in his work . . . and thereby builds everything to the exacting tolerances required.



Quality control graph . . . without pride in product.



Quality control graph . . . with pride in product.

The atmosphere here at Cannon, since our inception in 1915, has included a design and manufacturing philosophy embracing the highest quality and reliability in each Cannon Plug for the specific application for which it is to be used. *To these principles all Cannon Plugs are built!* Even on connectors designed to customer or MIL-spec we constantly strive to give even more . . . to increase the safety factor . . . to give that "something extra" according to our own high "Cannon Standards", as exemplified in our Cannon Credo.

THE CANNON "CREDO"

TO DEVELOP *an organization of exceptional people possessed of respect for the dignity of the individual and imbued with the spirit of the team.*

TO PROVIDE *a facility with which we can produce to our utmost in an efficient and pleasant environment.*

TO DEVELOP *and produce products of such quality, and render such service, that we may always be proud of our efforts.*

TO MARKET *the product of our endeavor at a reasonable profit for continuing growth, reward for effort and a return on investment.*

TO ACCEPT *our responsibility to our community, our country, and our fellow man.*

The Cannon "Credo" is posted through all departments of all Cannon plants . . . Copy available to you on request.

On the more technical side . . . we at Cannon have attempted not only to provide the proper climate for a complete reliability program from the viewpoint of mental attitude, but to provide the necessary facilities in which that attitude may work effectively. One of the most important of such fields is that of engineering organization and proper utilization of specialized engineering personnel. As a purchaser of Cannon Plugs, with a personal stake in their reliability, you will be interested to know that our engineering divisions are grouped as follows:

Master Planning Group . . . men who look to the future . . . investigating the newest in technological improvements, providing interplant project coordination for maximum flexibility to meet the challenges of our ever-changing future.

Industrial Engineering Group . . . experts who call out the materials, methods, and processes to be used in the manufacturing cycle . . . experts who collect, analyze, and institute corrective action in accordance with field failure data.

Sales Engineers . . . fully qualified technical men who contact our customers.

Design Engineers . . . specialists in past and present design methods who analyze failure data caused by design inadequacies and initiate corrective action.

Development Engineering and Model Shop Group . . . specializing in the development of prototypes. In these Laboratories, your prototype is tested to see that all specifications are met . . . physical, operating, environmental. Test reports are made up, and presented to you for review and approval. Not until all these steps have been taken is your order placed in production.

Product Engineers . . . specialists in particular types of connectors.

Quality Control Group . . . well qualified to administer the high requirements of "Cannon Standards" . . . staffed by well trained inspectors and analysts equipped with the most modern equipment.

Quality Engineering Group . . . handling the technical aspects of sampling plans . . . preparing inspection and test procedures to realize the customer's desired quality level and the over-all quality level of the entire Cannon manufacturing operation. Materials are processed through receiving inspection. Process, re-work and final inspection barriers are set up. In addition to standard Military and Cannon manuals of quality control procedures, specific jobs . . . such as yours . . . may require additional special inspection or testing. If so, these requirements are established throughout the process, and where necessary, coordinated with you. Our failure data collection and analysis in this field has given us intimate knowledge of the critical points at which such control should be used. Recognized statistical control procedures are used both in process and at the inspection points.

Materials and Processes Laboratory Group . . . working in both the research and production phases. This is the group that checks performance of new designs, constantly investigates new materials and processes, and (over and above normal manufacturing supervision and quality control operation) runs continuous reliability and assurance tests on the manufacturing cycle.

* * *

Each of our 20,000 Standard Cannon Plugs are of highest quality and were designed to meet exacting reliability requirements. We also produce special designs to meet the most exceptional AQL end-use requirements.

If you have a problem requiring high-reliability Cannon Plugs, we would appreciate the opportunity working with you.

Cordially,

Robert J. Cannon *President*

CANNON ELECTRIC COMPANY
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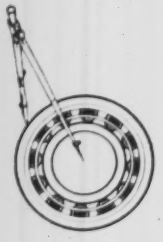
Please Refer to Dept. 417

CANNON PLUGS

Eight plants around the seven seas!

Hyatt's Simplified Fitting Practice for Bearing Races



HYATT pioneered the use of carburizing type alloys in order to obtain the advantages of heavier race fits

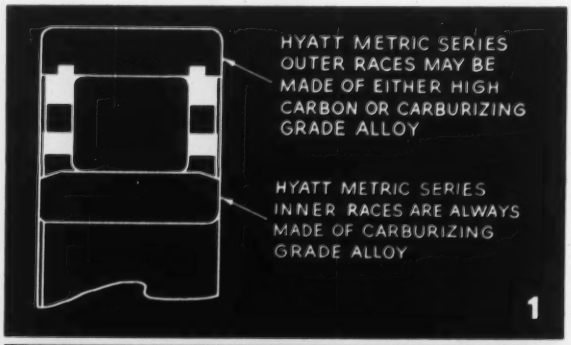
To obtain the best possible performance, roller bearing races must be assembled on shafts and in housings with certain fits developed by design and experience. The most frequent condition to be met is a rotating shaft where specific load and speed conditions must be satisfied with appropriate race fits. These vary according to the manufacturer, and in the case of some manufacturers, according to the application. Naturally, the fits will also vary according to bearing type and size.

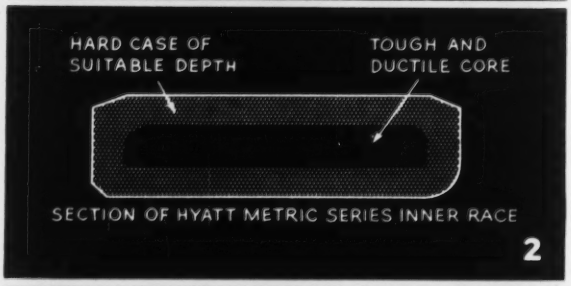
1. CARBURIZING PERMITS HEAVIER INTERFERENCE FITS

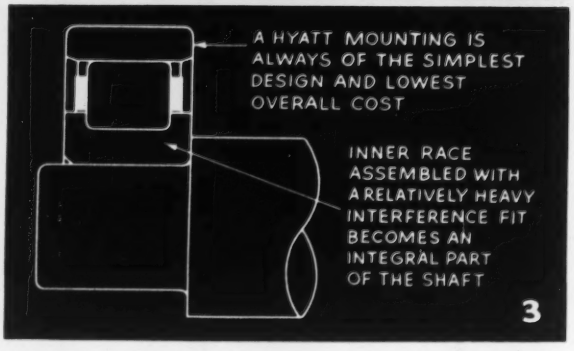
Taking the standard metric series of cylindrical roller bearings for an example, the bearing user has the choice of two fitting practices. One involves the use of inner races made of through-hardening steel, which dictates fairly light interference fits to avoid splitting. The other utilizes races made of low carbon steel *carburized* and hardened to develop a suitable surface hardness and a tough ductile core. The latter permits much heavier interference fits and has the additional advantage of eliminating all auxiliary holding devices, because the race becomes practically an integral part of the shaft. (Figs. 1, 2.)

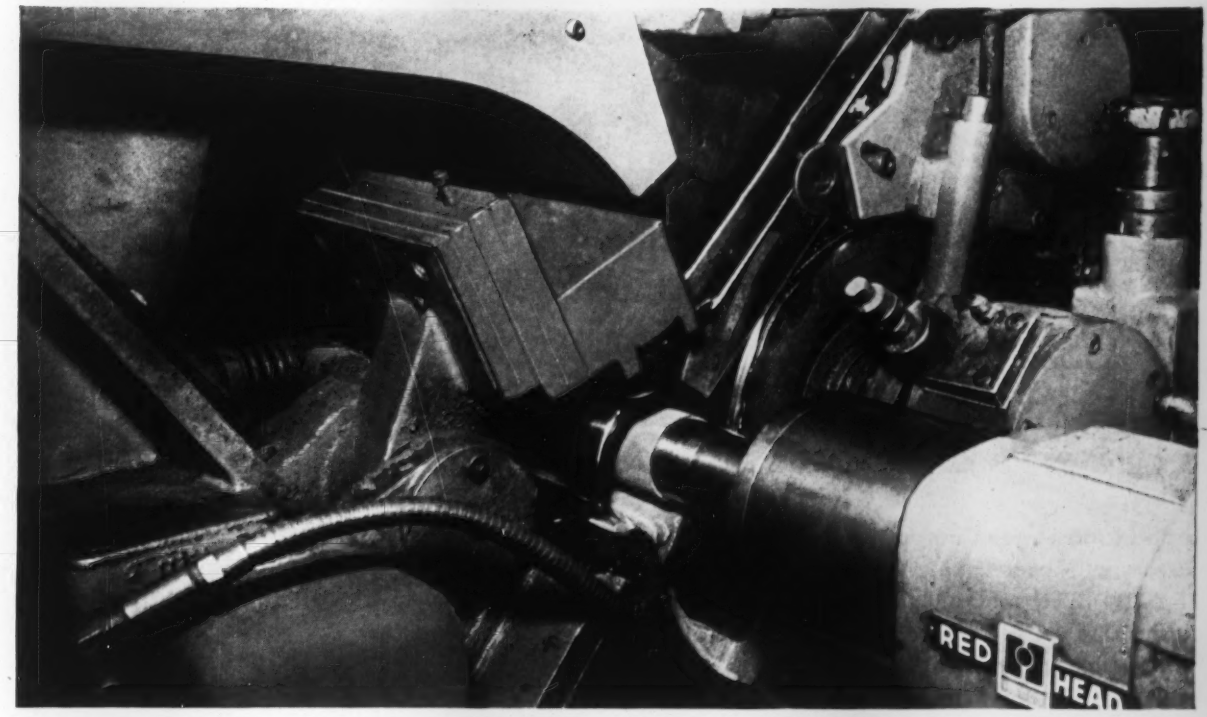
2. HEAVIER FITS SIMPLIFY MOUNTING, REDUCE COSTS

Hyatt originated the carburized race and the system of relatively heavy inner race fits to simplify bearing mounting and eliminate the need for retaining devices. Practically all HYATT inner races are made from nickel alloys of the carburizing type. They permit mountings of the simplest type and lowest over-all cost. Furthermore, the shoulders of HYATT carburized races will withstand considerably greater impact loads than will ordinary races. (Figures 3 and 4.)


HYATT METRIC SERIES OUTER RACES MAY BE MADE OF EITHER HIGH CARBON OR CARBURIZING GRADE ALLOY
HYATT METRIC SERIES INNER RACES ARE ALWAYS MADE OF CARBURIZING GRADE ALLOY
1




A HYATT MOUNTING IS ALWAYS OF THE SIMPLEST DESIGN AND LOWEST OVERALL COST
INNER RACE ASSEMBLED WITH A RELATIVELY HEAVY INTERFERENCE FIT BECOMES AN INTEGRAL PART OF THE SHAFT
3

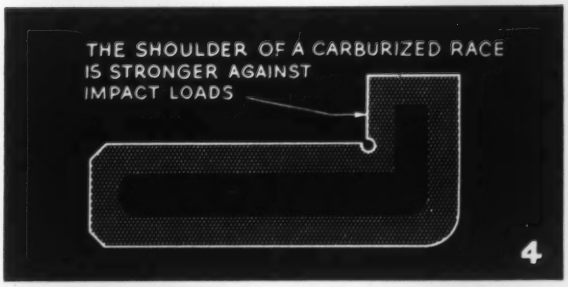


Hyatt inner race being centerless I. D. (inside diameter) ground to close tolerances.

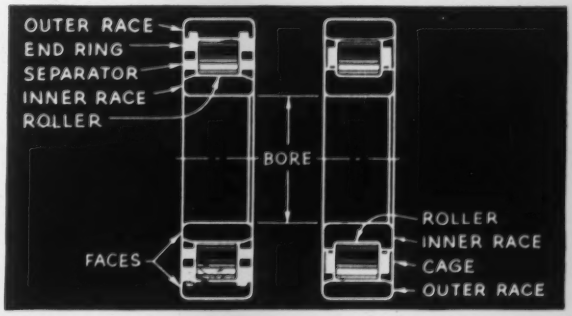
There are two fitting specifications which apply to HYATT inner races, depending on whether the inner race rotates or is stationary in operation. Remember, with both inner and outer race, the rotating member is assembled with heavier fit.

3. HYATT INNER RACES CAN BE EASILY SHRUNK ON SHAFTS

HYATT inner races may be mounted on shafts by pressing or shrinking. Where shrinking practice is employed, first heat the race in oil held at a temperature not over 300°F, or in an electric oven under a similarly controlled temperature, until it expands sufficiently to be slipped into position. The required interference fit will develop as the race cools in place. For special conditions of fit involving hollow shafts of varying sections or multiple housings of dissimilar metals, consult your HYATT Sales Engineer from our nearest sales office.



COMPONENT PARTS OF A HYATT ROLLER BEARING



YOU WILL FIND MORE DETAILS in HYATT Catalog No. 150. If you do not have a copy, write Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey. Sales offices at Harrison, Pittsburgh, Chicago, Detroit and Oakland, California.

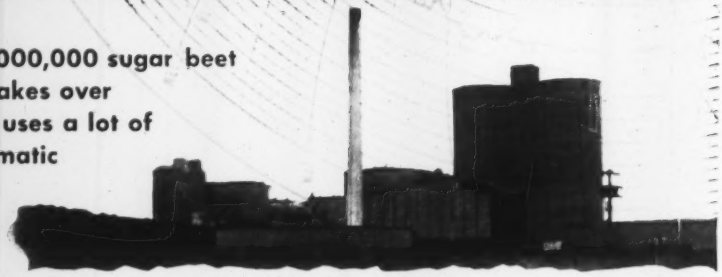
GM GENERAL MOTORS

HYATT HY-ROLL BEARINGS FOR MODERN INDUSTRY

Process CO_2 and Steam Needs Met on Low Grade Western Coal

with REPUBLIC *Automatic* COMBUSTION CONTROLS

Utah-Idaho Sugar Company's new $7,000,000 sugar beet factory at Moses Lake, Washington, makes over 75,000,000 lbs. sugar each year, and uses a lot of steam and CO_2 to do it. Republic automatic combustion controls meet these multiple needs efficiently.

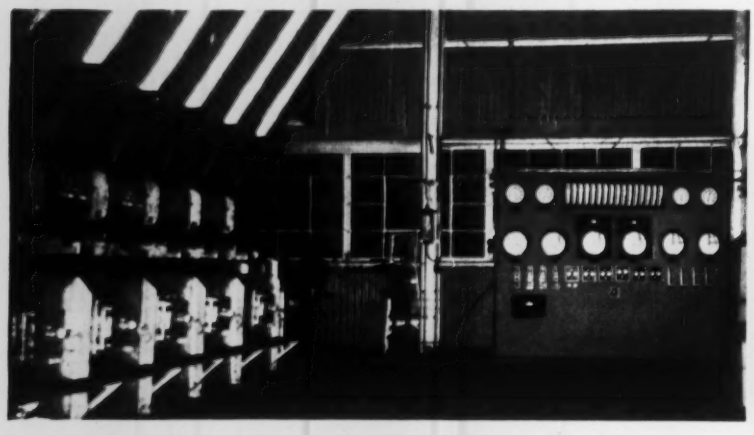


High CO_2 in the flue gas is an important indication of combustion efficiency, but it has added importance at the new Moses Lake plant of the Utah - Idaho Sugar Co. High CO_2 production must be maintained to assure adequate supplies of the gas for processes, and the concentration of CO_2 in the flue gas is important to the cost of its extraction.

Republic Automatic Combustion Controls keep the CO_2 at a high 12-13%, despite the low-grade western coal being burned.

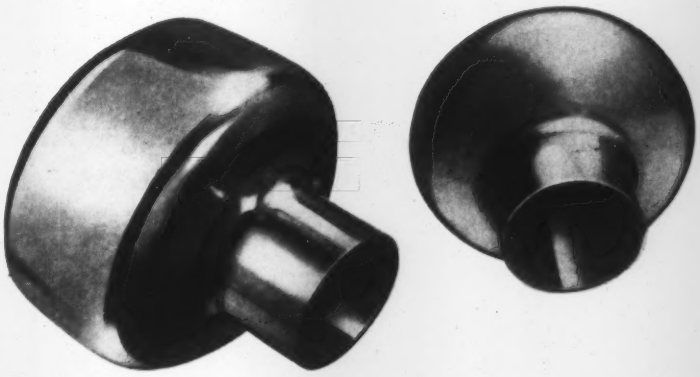
The plant's spreader-stoker-fired 250,000 lb/hr boiler must be regulated to meet the CO_2 quantity and concentration requirements while furnishing the needed process steam at top efficiency. Plant operators report that the Republic controls meet these multiple requirements even during ash removal, soot blowing, and fire cleaning—without disturbing the fuel-air ratio and *while on fully-automatic control.*

Speed-controlled forced and induced draft fans regulated by the combustion controls maintain proper draft without dampers, and despite a high stack. A three-element Republic boiler feedwater system is also regulated by the combustion controls to meet water requirements at all steaming rates.



This plant is another example of how Republic combustion engineers can work to unusual and rigid specifications in designing and building combustion controls for individual requirements. To get top boiler performance and those extras that your plant needs, ask Republic to design and build your combustion control system.

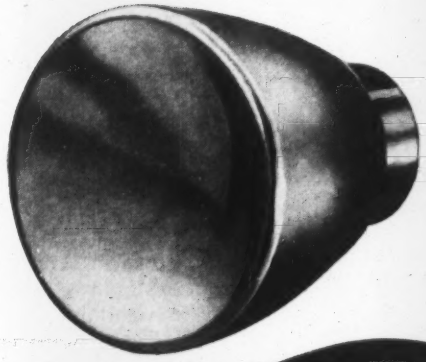
REPUBLIC
FLOW METERS CO.
2240 Diversey Parkway
Chicago 47, Illinois



4 OF THE MANY STYLES OF THE ONE-PIECE SEAMLESS DOOR KNOBS FABRICATED FROM RUGGED REVERE BRASS STRIP.

REVERE BRASS STRIP

Stands the Gaff!



The one-piece door knobs shown are drawn from a single blank of Revere Brass Strip, presenting an attractively smooth, unbroken surface without the need for seams or welds.

Because they are made by a unique procedure the manufacturer tells us that the brass must stand up under mighty rugged going, and that to produce the quality knobs they do, at an economical production level, the brass they use must have:

1. *Uniformity of gauge.*
2. *Absence of any sign of fracture or crimping when drawn.*
3. *Consistently correct grain structure to insure a smooth, flaw-free surface on the finished knobs.*

The manufacturer also tells us that Revere Brass Strip has been filling that bill, with utmost satisfaction, for some time.

Revere Brass Strip may be able to help *you* make a better product at less cost. You'll never know until you talk it over with one of our TA's (Technical Advisor). There's no obligation, of course. And such a discussion could save you a substantial sum of money. Such has been the case many, many times.

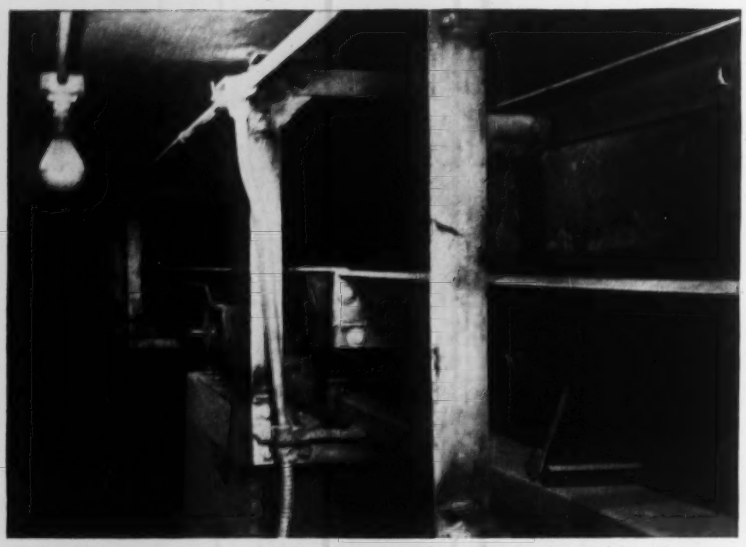
COPPER * BRASS * 18 01 * REVERE * ALUMINUM

REVERE COPPER AND BRASS INCORPORATED

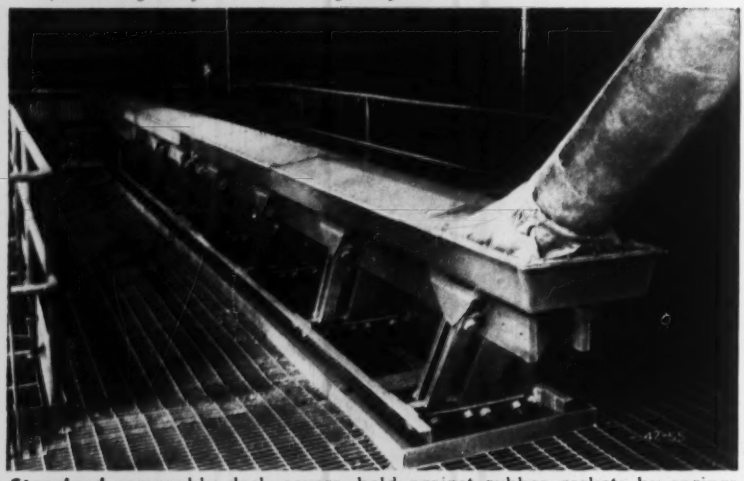
Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

Mills: Baltimore, Md.; Brooklyn, N. Y.; Chicago, Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Newport, Ark.; Rome, N. Y. Sales Offices in Principal Cities, Distributors Everywhere.



This LMV conveyor carries broken glass from inspection tables through tunnel to a Jeffrey crusher and Jeffrey elevator.



Standard removable deck covers, held against rubber gaskets by springs make this HMV conveyor dust-tight.

HMV heat expansion type conveyors like this one in a malleable iron foundry serve as cooling tables while carrying castings from shake-out.

JEFFREY "MV" CONVEYORS

for effectively and economically conveying large, medium and light tonnages

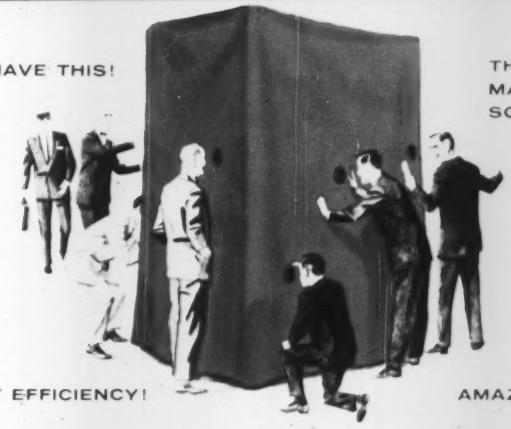
Jeffrey *M*echanical *V*ibrating conveyors are simple in design, rugged in construction and dependable in operation. Behind them is the know-how gained by Jeffrey in thirty years of making and applying electric vibrating equipment to conveying, feeding and processing operations.

MV conveyors provide capacities ranging from a few pounds to over 650 tons per hour, depending on material, grade and width of conveyor. They can handle hot or abrasive materials. They may be enclosed for use with gaseous, dusty or toxic materials, or for conveying them in an inert atmosphere.

Designed to give dependable, around-the-clock service, Jeffrey MV conveyors assure long life with a minimum of maintenance. Their balanced vibration provides quiet, low-cost operation. Catalogs 859 and 890 describe these conveyors. The Jeffrey Manufacturing Company, Columbus 16, Ohio.

JEFFREY

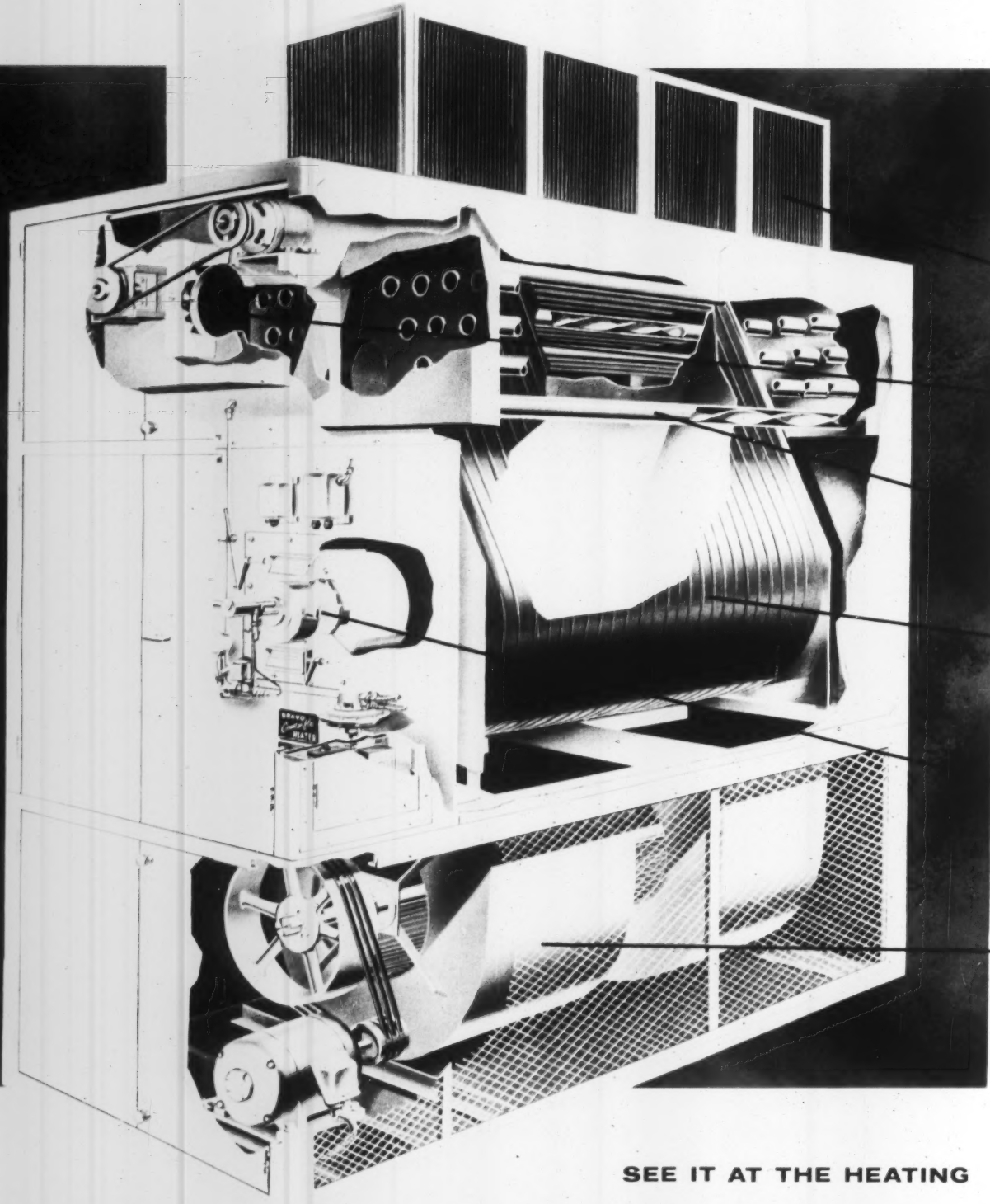
CONVEYING • PROCESSING • MINING EQUIPMENT...TRANSMISSION MACHINERY... CONTRACT MANUFACTURING



The BIGGEST NEWS in SPACE HEATING

The ALL-NEW DRAVO

with the revolutionary



SEE IT AT THE HEATING

COUNTERFLO HEATER

PYROJET

BURNER

From top to bottom, the NEW Dravo *Counterflo* is built around a completely new concept of burning fuel to produce efficient space heating. The heart of the new heater is the PYROJET burner — the first burner specifically designed for use in direct-fired space heaters. The PYROJET is an exclusive development of Dravo research. Here are a few of the many features of the all-new Dravo:

NEW discharge plenum distributes heat at high velocity without annoying drafts. New design cuts air flow resistance, steps up heater efficiency.

NEW induced draft fan adds to safety by maintaining high negative pressure in combustion chamber, assures accurate flow of combustion air. Positive acting vacuum switch must be closed for burner to operate.

NEW economizer tubes provide high heat transfer to air stream. New location saves space, adds efficiency. Aluminized steel construction for long life.

NEW stainless steel combustion chamber — guaranteed for 10 years — presents perfect airfoil shape to moving airstream. Resistance to airflow is lowered, and heat transfer efficiency raised. Large sizes ribbed to add strength — channel higher air-flow.

NEW PYROJET dual fuel burner. Designed specifically for the New Dravo *Counterflo*, this revolutionary burner offers many features (see box at right) including ability to burn thick No. 5 oil successfully, and automatic switchover from gas to light oil.

NEW low horsepower fans — horsepower requirements in the New Dravo *Counterflo* have been reduced. Forwardly curved, slow-speed, double inlet fans move air efficiently with air/heat ratios of 12,500 cfm to 16,000 cfm per 1,000,000 btu/hr output.

COMPLETE RANGE OF SIZES from 250,000 to 2,000,000 btu — nine models to suit every type of building — plants, warehouses, schools, offices.

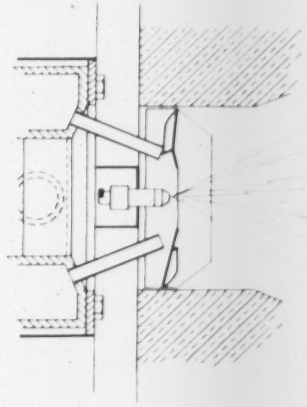
VERSATILE INSTALLATION can be floor mounted, suspended horizontally or inverted. Adapts readily to use with ductwork if desired.

MAXIMUM SAFETY completely new electrical system adds to safety, speeds inspection and maintenance. Extremely simple to hook up, or to add additional controls.

NEW DRAVO

PYROJET **BURNER**

"Ring and Finger" design



First burner designed specifically for direct-fired space heater, the PYROJET burns oil, gas or heavy oil efficiently in any position.

- Special air-atomizing nozzle *burns heavy No. 5 oil with high efficiency.* Dravo-designed "V-heater" assures quick, smooth starts.
- Provides instant heat.
- Automatically switches from gas to light oil during operation.
- Burner design keeps oil from fouling gas burner.

AND VENTILATING SHOW • *Chicago* • *February 25-28*

or ask your nearest Dravo representative (see list on back) for details

Intensive research developed the many new features of the Dravo Counterflo heater

PYROJET

The new Dravo *Counterflo* heater, with the revolutionary PYROJET burner, is the result of several years of intensive research. It is easy to install, operate and maintain, and will give you many years of safe, efficient heating.

Ask the Dravo representative nearest you. He will be happy to show you how the new Dravo *Counterflo* heater can save you money.

REPRESENTATIVES

BIRMINGHAM, ALABAMA
Clisby and Moore, Inc.
LOS ANGELES, CALIFORNIA
Harry F. Haldeman, Inc.
SAN FRANCISCO, CALIFORNIA
Dravo Corporation
DENVER, COLORADO
Killam Gas Burner Company
HARTFORD, CONNECTICUT
Wilson C. Blake Company
JACKSONVILLE, FLORIDA
Charles H. Liphart & Son
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Food Machinery Corporation
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SYRACUSE, NEW YORK
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Atlantic Engineering Co., Inc.
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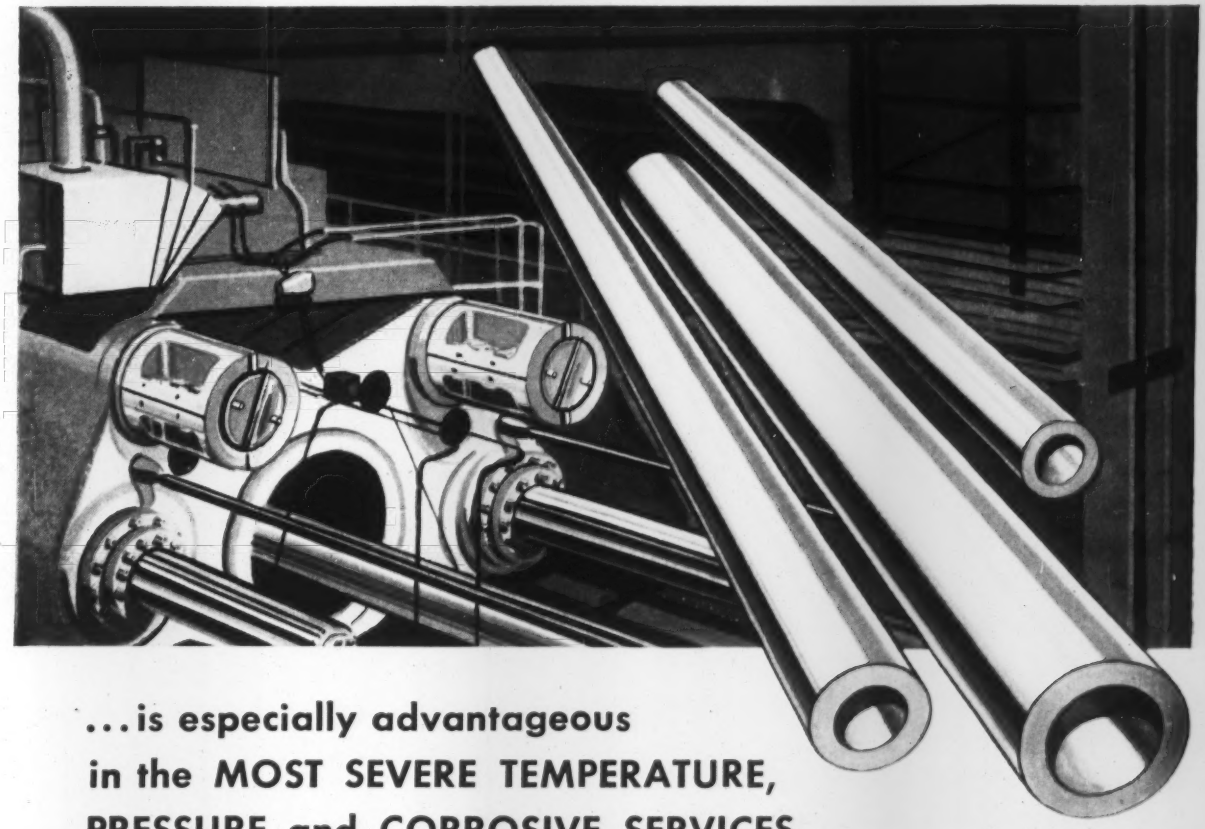
DRAVO
CORPORATION

Fifth and Liberty Avenues, Pittsburgh 22, Pennsylvania

HIGH INTEGRITY

EXTRUDED ALLOY STEEL PIPE

available from 4″ to 22″O.D. in practically any wall thickness



...is especially advantageous in the MOST SEVERE TEMPERATURE, PRESSURE and CORROSIVE SERVICES

A specially-built 12,000 ton extrusion press — capable of processing any of the stainless or other ferrous alloys — imparts vastly improved mechanical properties to new Curtiss-Wright ***HIGH INTEGRITY*** pipe. *High ductility with high strength* and *higher resistance to stress at high temperature* are automatically built into even the largest diameters and thickest-wall products. In the larger diameters, 10″ and above, the economics of ***HIGH INTEGRITY*** pipe are particularly attractive.

Major economies are regularly effected in fabrication and installation . . . using the longer units — up to 50 feet. Ultrasonic testing of all ***HIGH INTEGRITY*** pipe — combined with the more conventional test methods — assures uniform, dependable, specification quality of delivered product.

Curtiss-Wright's Metals Processing Division maintains qualified engineering personnel at all branch offices, available for design consultation and specification pricing.

84 GRIDER STREET

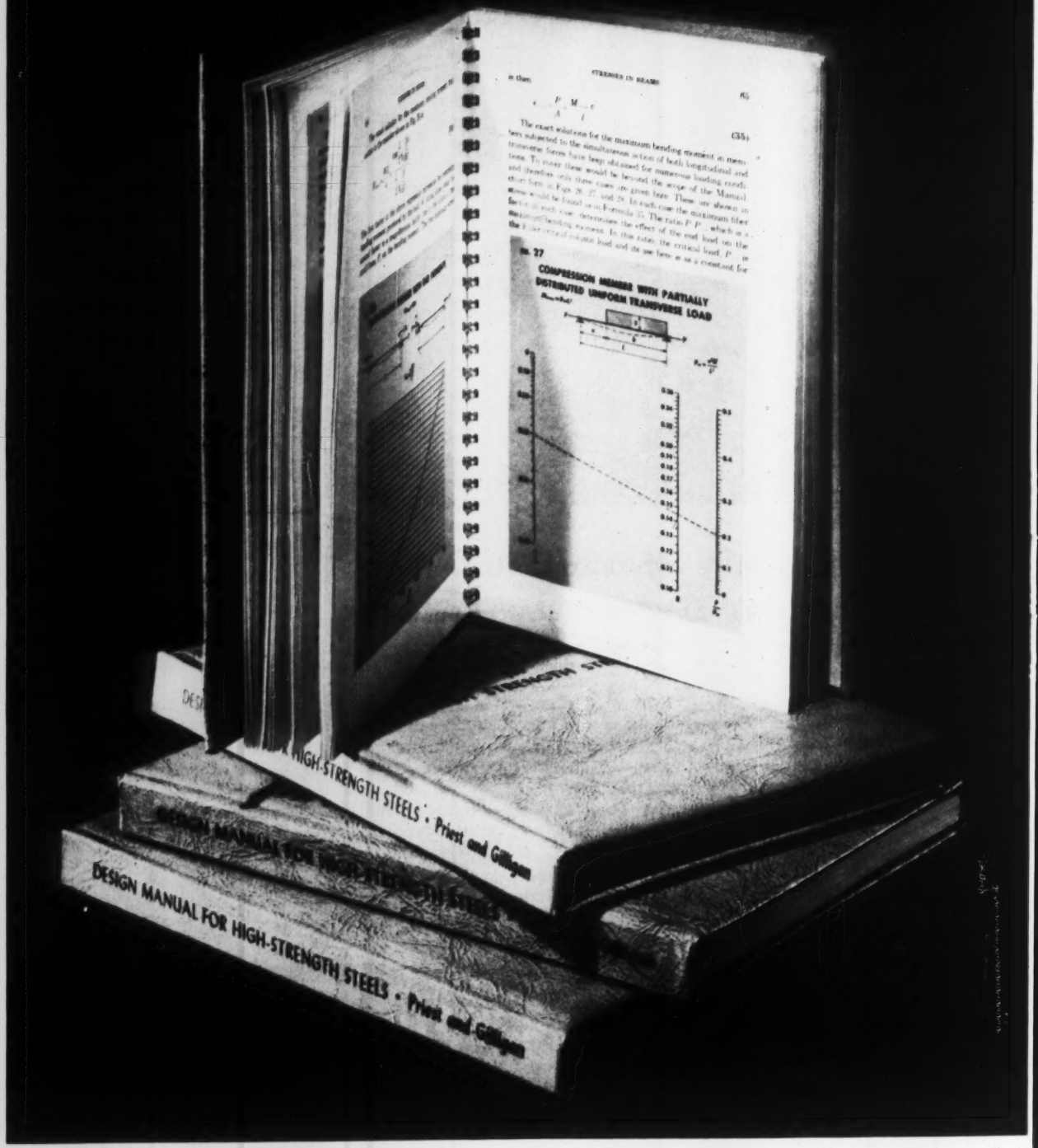
METALS PROCESSING DIVISION

CURTISS-WRIGHT (CW)

CORPORATION • BUFFALO, NEW YORK

METALS PROCESSING DIVISION BRANCH OFFICES: . . . . . NEW YORK • HOUSTON • LOS ANGELES

Why have 34,129 engineers


DESIGN MANUAL FOR HIGH-STRENGTH STEELS • Priest and Gilligan
DESIGN MANUAL FOR HIGH-STRENGTH STEELS • Priest and Gilligan

written us for copies of this unusual book?

Every day we receive an average of 70 requests for our "Design Manual for High Strength Steels." This, despite the fact that in the past two years we have distributed 54,096 of these Manuals—enough to make a stack three times as high as the Empire State Building.

Requests have come not only from design engineers for whose use this book was primarily written, but from men signing themselves as Research Engineer, Project Director, Development Engineer, Design Analyst, Process Engineer, Test Engineer, Mechanical Engineer, Chief Engineer, Methods Engineer, Materials Engineer, Marine Engineer, Industrial Engineer, Electrical Engineer, Aeronautical Engineer, Purchasing Agent, Plant Manager, Chief Inspector, President, and so on and so on. We even had one from a Chairman of the Board. *(Looks like a lot of men besides design engineers are vitally interested in High Strength Steels and want to know how, when, where and why to apply them.)*

While most of these requests have come from all parts of the United States and Canada, an amazing number have reached us from England, Germany, Belgium, France, Italy, South Africa, India, Japan, South America, Australia and New Zealand. *(Seems that no country is so remote that it hasn't heard the good word.)*

What's in this book that makes it such a "must have" for those who have seen it or merely heard about it?

We like to think that the "Design Manual" is finding its place on so many engineers' desks and book shelves—not because it is a costly book, free for the asking—but because it *contains information nowhere else available* and never before presented so clearly and comprehensively.

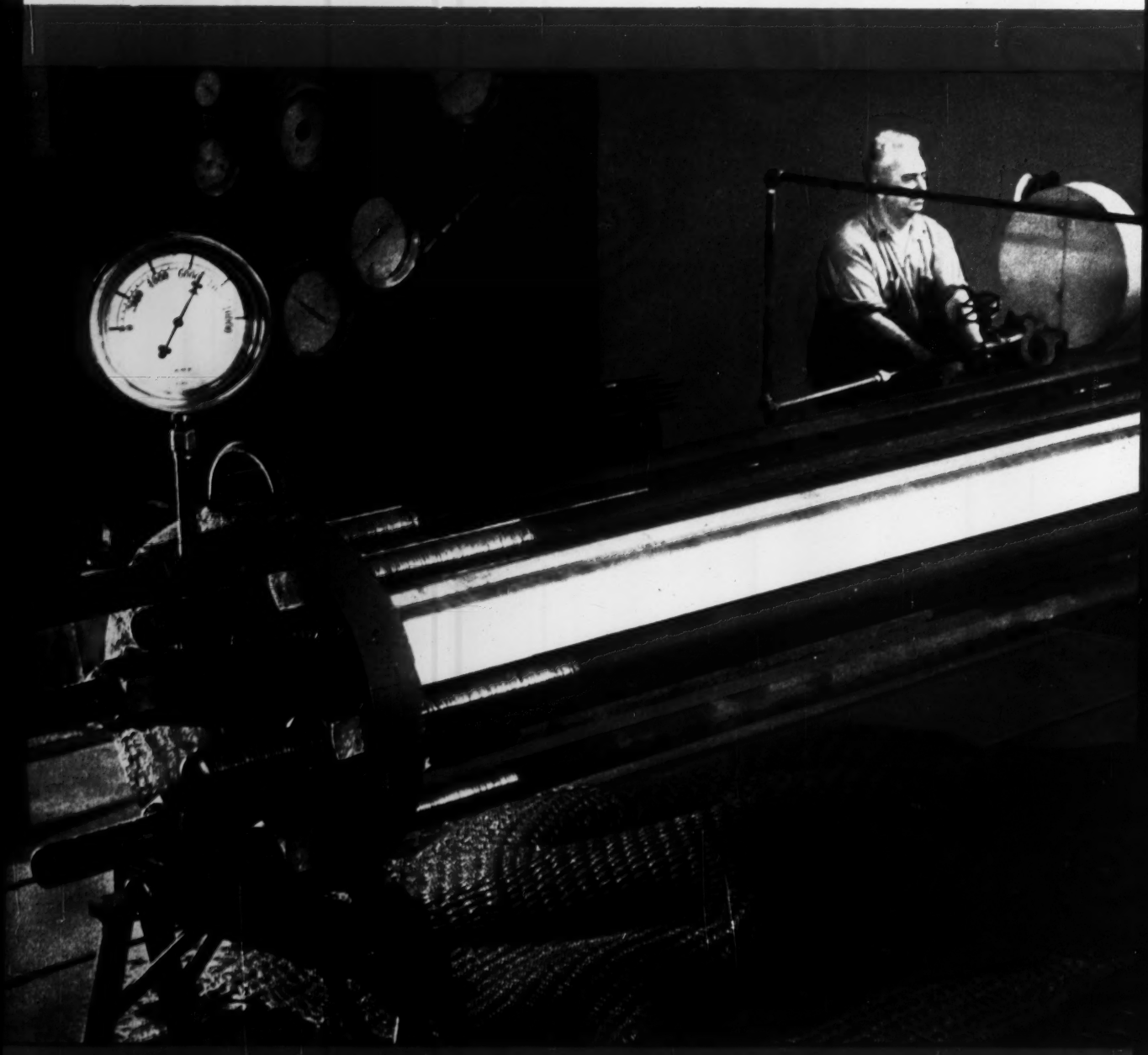
For here, in one volume, the design problems of tension, compression, shear, beam stress, deformation, and deflection are covered in detail, the fundamental characteristics of high-strength low-alloy steels that result in economies to the user are described, the principles of designing against corrosion, and the application and advantages of formed sections are authoritatively discussed.

Complete with tables, formulas and basic data covering every facet of this important subject, the 174-page "Design Manual for High Strength Steels" is a book that you will find invaluable in designing your product for greater efficiency and economy. A fourth printing is now on the presses. We will gladly send you a free copy if you will write — *on your company letterhead*, giving your title or department—to United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

USS

UNITED STATES STEEL

STAINLESS STEEL CENTRIFUGALLY CAST MAY BE



ABOVE: Hydrostatic test rig used to qualify each length of pipe.

UNITED STATES PIPE & FOUNDRY CO.

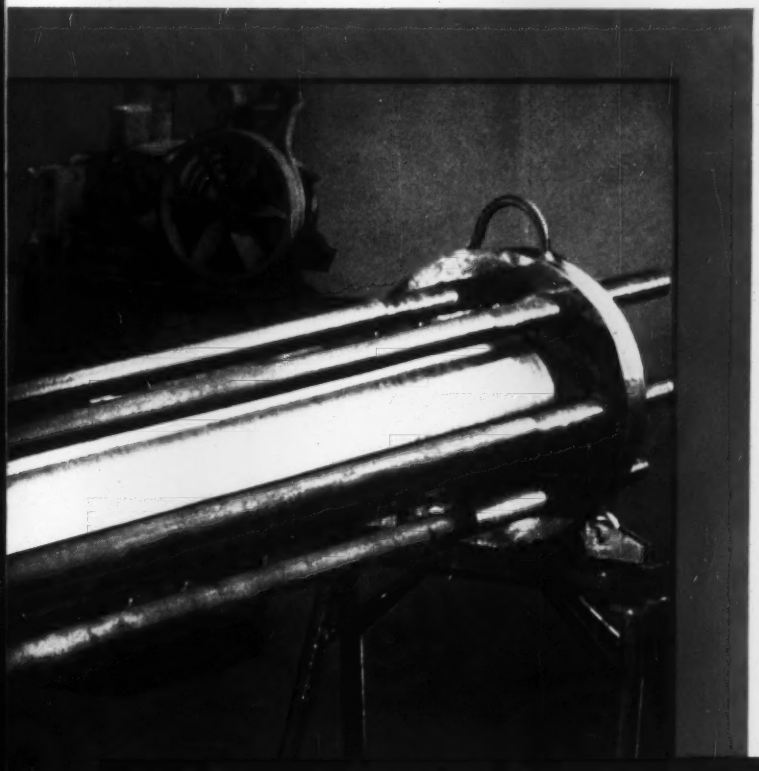
Steel and Tubes Division

STEEL & TUBES U.S. PIPE DIVISION

BURLINGTON, NEW JERSEY

SALES OFFICES: LOS ANGELES, SAN FRANCISCO, CHICAGO, ST. LOUIS, COLUMBUS, DETROIT, PITTSBURGH, HARTFORD, BURLINGTON

THE ANSWER TO YOUR PIPING PROBLEM



Patented U. S. Pipe process meets rigid refinery specifications

The men who design today's petrochemical plants, refineries or Atomic power plants are confronted with piping problems involving temperatures, pressures and corrosive conditions which only a few years ago would have been called impractical, if not impossible.

U. S. Pipe's Steel & Tubes Division recently completed a piping requirement for 700 feet of Type 316 Extra Low Carbon, columbium-bearing stainless for a large petrochemical plant, which is typical of the job metal mold centrifugally cast pipe is doing today under a patented manufacturing process with rigid Quality Control.

U. S. Pipe is headquarters for metal mold centrifugally cast alloy and stainless steel pressure pipe over a wide range of special and standard analyses —in large or small quantities.

Write and outline your refining problems. We may be able to help.

Note these exacting specifications on 316 Cb ELC Stainless Steel Pipe demanded by one of nation's leading oil companies:

MATERIAL REQUIREMENTS: Pipe shall conform to ASTM Specification A-362-52T.

CHEMICAL ANALYSIS: Modified AISI Type 316 Cb (ELC), with *one percent* spread on chrome and nickel.

FINISH: Each pipe to be turned, bored and faced to surface finish of 125 micro inch or better. O.D. tolerance plus 1/16″ minus 0″; I.D. tolerance plus 0″ minus 1/32″. Pipe size: 12″ O.D. × 1.17″ wall.

MECHANICAL TESTS: Tensile Tests — 2 tests required on each pipe after heat treatment; one at room temperature, one at 700° F.

INSPECTION REQUIREMENTS

1. Etching test on sections cut from each end of pipe.
2. Radiographic Inspection — Required complete circumferential coverage of at least an 8″ wide section at each end of each pipe in accordance with ASTM Specification E71-52.
3. Fluid Penetrant — Entire O.D. and I.D. surface each piece.

HEAT TREATMENT: Heat for 4 hours at 2100° F.—2150° F., water quench, follow by 5 hours at 1500° F.—1600° F. Cool in still air.

HYDROSTATIC TEST: Each length tested to stress of either 90% of the minimum cold yield strength or a maximum pressure of 6800 psi — whichever is lower.

SIZE RANGE AND COMPOSITION FLEXIBILITY

Outside Diameter—6″ to 50″
Wall Thickness—⅜″ and up
Length—Up to 16′
Types of Stainless—All Standard AISI and ACI grades of ferritic and austenitic stainless, including No. 20 Alloy, 17-4 P H, 17-7 P H and E.L.C. grades.

Change motors in minutes—

with FALK all-steel MOTOREDUCERS

No long and costly "down time" involved

Motors can be interchanged or replaced *in minutes* with the all-steel, All-Motor type FALK Motoreducer. No long and costly "down time" is involved in making the change!

Best of all, replacement is not limited to original make of motor—new NEMA frames may be substituted for old. This versatile Motoreducer operates with any make, speed or type of standard foot-mounted motor within its AGMA rating. No modification, no special shaft, no "partial" motor required.

In addition to unmatched motor interchangeability, this dependable gear drive—the "work horse of industry"—offers: widest choice of output-shaft position (horizontal, vertical, right-angle)...any output-shaft connection...any mounting, including wall and ceiling...standard speed range from 1.5 rpm to 1430 rpm. All these advantages, plus proved efficiency, low maintenance and extra-long life, make the All-Motor type FALK Motoreducer your best buy for any job requirement.

Furnished in sizes up to 75 hp with any make, style or type of motor; or, *without a motor if desired.* FALK Motoreducers are available from convenient factory, field or distributor stocks, from coast to coast.

Write for Bulletin 3100

THE FALK CORPORATION, MILWAUKEE, WISCONSIN

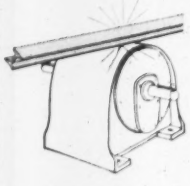
MANUFACTURERS OF:

- Motoreducers
- Speed Reducers
- Flexible Couplings
- Shaft Mounted Drives
- High Speed Drives
- Special Gear Drives
- Single Helical Gears
- Herringbone Gears
- Marine Drives
- Steel Castings
- Weldments
- Contract Machining

FALK

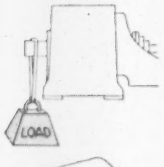
...a good name in industry

FALK "IN-BUILT" FACTORS assure full dependability—better service—longer life



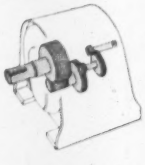
ALL-STEEL HOUSINGS

Rugged, strong, rigid ...all parts heavy steel plate, formed and welded in the Falk Weld Shop.



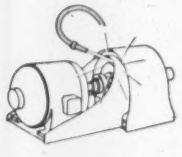
LARGE OVERHUNG LOAD CAPACITY

Large shafts, oversize bearings...rigid mountings with wide bearing spans to handle maximum loads.



PRECISION GEARING

Heat-treated alloy steel gearing, precision cut and shaved after heat treatment to eliminate distortion.



SEALED HOUSINGS

Splashproof, dustproof, oiltight. Dual closures and one-way vents keep oil in, dust and moisture out.

ADSCO

EXPANSION JOINTS

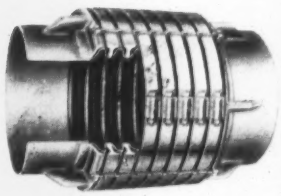
ARE MORE EFFICIENT THAN EXPANSION BENDS...

and they cost less

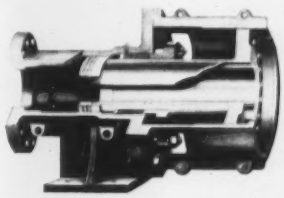
ADSCO Expansion Joints are more efficient than pipe bends for three important reasons:

1. **LESS HEAT LOSS.** A 12-inch line 1000 feet long, carrying steam at 200 lbs. and 550 F, will lose 16% more heat if bends are used instead of ADSCO Expansion Joints.
2. **LESS PRESSURE DROP.** The same line will have a 28% greater pressure drop with bends than with ADSCO Expansion Joints.
3. **LESS SPACE.** One pipe bend requires 100 to 300 sq. ft. of valuable space. An ADSCO Expansion Joint requires little or no extra space.

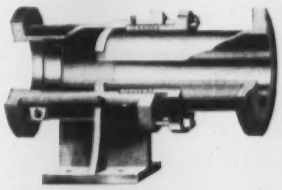
And, in addition, ADSCO Expansion Joints cost less. Used to absorb 4 inches of expansion per 150 feet of 12-inch pipe, an expansion bend, or loop, will cost 50% to 100% more than an ADSCO Expansion Joint. Similar savings can be obtained for other sizes of pipe and for different conditions.



Corruflex Packless Expansion Joint. Requires no maintenance.



Piston-Ring Expansion Joint. Can be unpacked at full operating pressure.



Internally Guided Expansion Joint. Traverses of 4", 8", and 12" per slip.

If you are planning construction of a pipe line, by all means investigate ADSCO Joints. If you already use bends, ADSCO can replace them with joints which will perform better and will still save money.

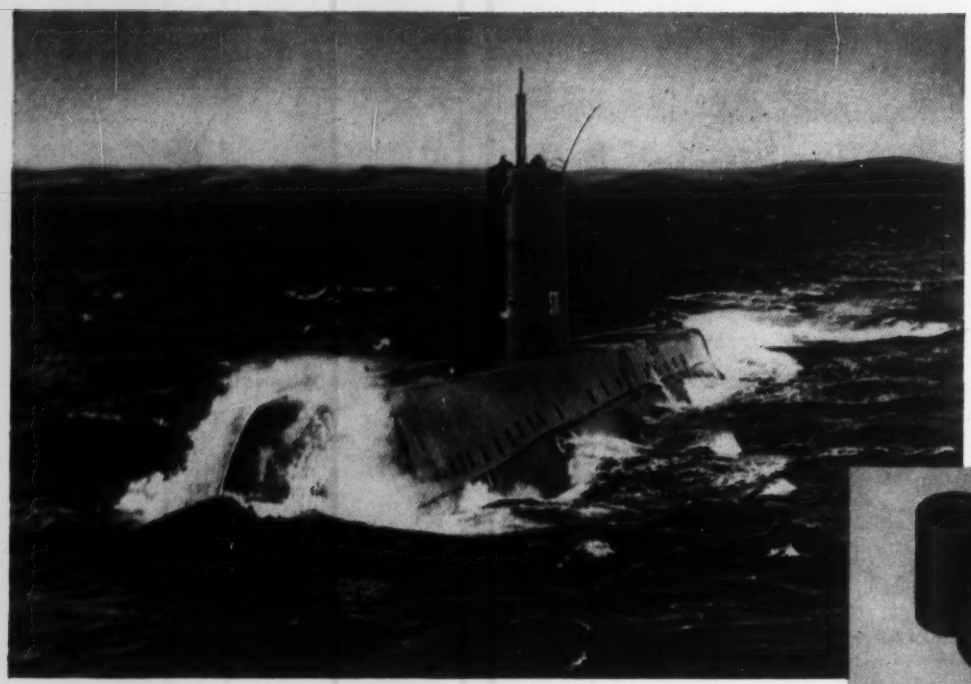
- *Write for Bulletins 54-10 PR and 35-51 PR*

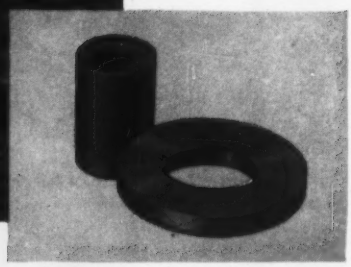
ADSCO ENGINEERED PRODUCTS

AMERICAN DISTRICT STEAM DIVISION
ADSCO INDUSTRIES, INC.
20 MILBURN ST. BUFFALO 12, N. Y.

Are your seals or bearings subject to difficult operating conditions?

GRAPHITAR® (Carbon Graphite) has the specific properties needed in difficult applications like these . . .



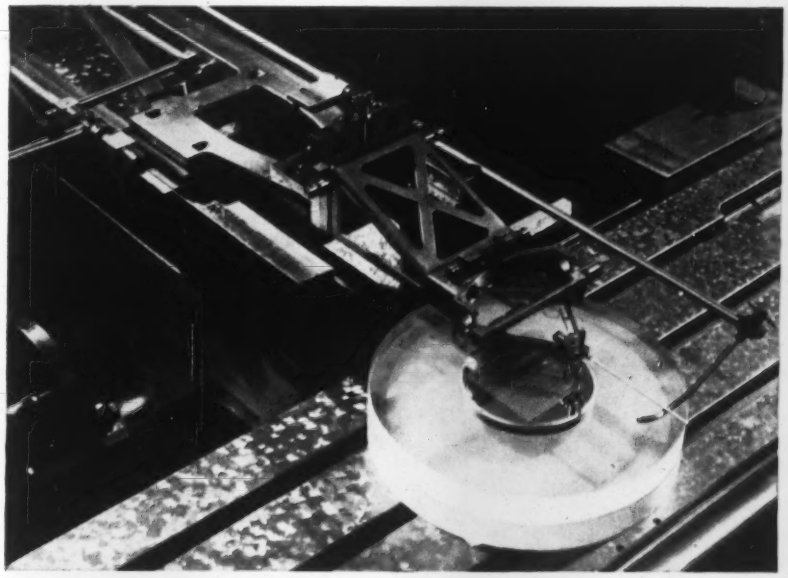


THE MOST IMPORTANT BEARING

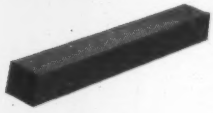
Dependability is vital in the power plant of the Navy's atomic submarine U.S.S. Nautilus which has steamed a total of about 50,000 miles of which approximately half has been submerged. In the reactor cooling system of the submarine, special "canned" motor pumps with integrated pump and drive motor were developed by Westinghouse. The bearings in these pumps, which are made of GRAPHITAR, must withstand high speeds, high temperatures, high pressures and must operate for indefinite periods of time without maintenance and with radioactive water as the only lubricant. Westinghouse Electric Corporation engineers—the builders of the Nautilus' atomic power-plant—find that GRAPHITAR is excellent for this difficult bearing application, because of its strength, durability, self-lubricating properties, and chemical inertness. If your design calls for superior bearings, consider the material that worked on such a demanding job.

THE UNITED STATES

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® SINTERED METAL PARTS • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

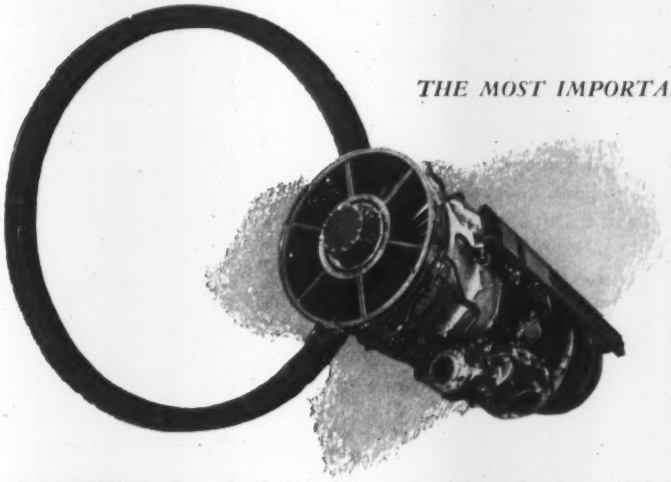


THE MOST EXACTING BEARING



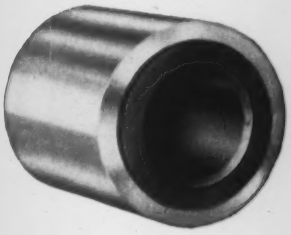
The Bausch & Lomb Optical Co. of Rochester, N.Y., world renowned manufacturer of precision, scientific optical instruments, employs 10 GRAPHITAR bearings in its unique and highly specialized "ruling engine." The GRAPHITAR bearings provide dimensional stability within one-millionth of an inch for micro-inch accuracy in cutting 15,000-30,000 equidistant lines to the inch on 7" aluminized glass blanks to make diffraction gratings used by science and industry for spectroscopic analysis. Bausch & Lomb engineers have found that GRAPHITAR is unsurpassed as a bearing material where very close tolerances must be maintained and where frequent starting and stopping under heavy loads is a problem. These bearings have contributed greatly to the achievement of extreme accuracy in this application. If you require precision performance as was the case with a "ruling engine" why not use GRAPHITAR?

THE MOST IMPORTANT SEAL



GRAPHITAR is the main shaft seal in the Pratt & Whitney J57 turbojet engine which powers many of our new aircraft, including the huge Boeing B-52 Intercontinental Bomber, which has eight of these turbojets. Naturally, the J57 must perform with utter dependability. One of the components of the J57 is the air/oil seal of GRAPHITAR on the turbine main shaft, and this seal is subjected to tremendous shaft speeds, as well as other taxing physical conditions. GRAPHITAR parts can stand severe operation because they are strong and are virtually unaffected by extremes of speed, pressure, and temperature. If your product develops high speeds or other difficult physical stresses on its parts, perhaps GRAPHITAR components could give it more dependable operation.

THE TOUGHEST APPLICATION



Steel mills are famous for the rough, tough, heavy-duty jobs that they perform. In such difficult steel mill applications as bearings for shear and cut-off tables or coil and slab conveyors, metal-backed GRAPHITAR parts provide exceptional strength and durability. GRAPHITAR alone is a very strong bearing material, and when backed with metal has added resistance to shock. Because of its very low coefficient of friction, GRAPHITAR can operate under heavy loads at high speeds with no lubrication. Can the strength and superb bearing qualities of GRAPHITAR simplify your product design?

Get your copy of Engineering Bulletin No. 20.

GRAPHITAR is compacted from carbon-graphite powders under great pressures, then furnaced at heats near 4500°F. It can be formed in relatively complex shapes and ground to tolerances as close as .0005". For more information on this strong, light, self-lubricating engineering material, write for our Engineering Bulletin No. 20.

218-4

GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN

AN IMPORTANT MESSAGE

to the customers and friends of Read Standard Corporation

Effective November 3, 1956, the Read Standard Corporation, 50-year-old manufacturer of Readco bakery and chemical processing equipment and Standardaire blowers, merged with and became a division of Capitol Products Corporation.

WHAT IS CAPITOL PRODUCTS CORPORATION?

Capitol Products Corporation is a young, progressive organization specializing in light metals fabrication. Principally, Capitol manufactures extruded aluminum products for the building industry. To date, this organization has enjoyed great success in both the manufacturing and marketing phases of its industry. For instance, in the highly competitive aluminum door business Capitol has become, in four years, the world's largest producer. This management now directs the Read Standard operation.

WHAT THIS MERGER MEANS TO YOU.

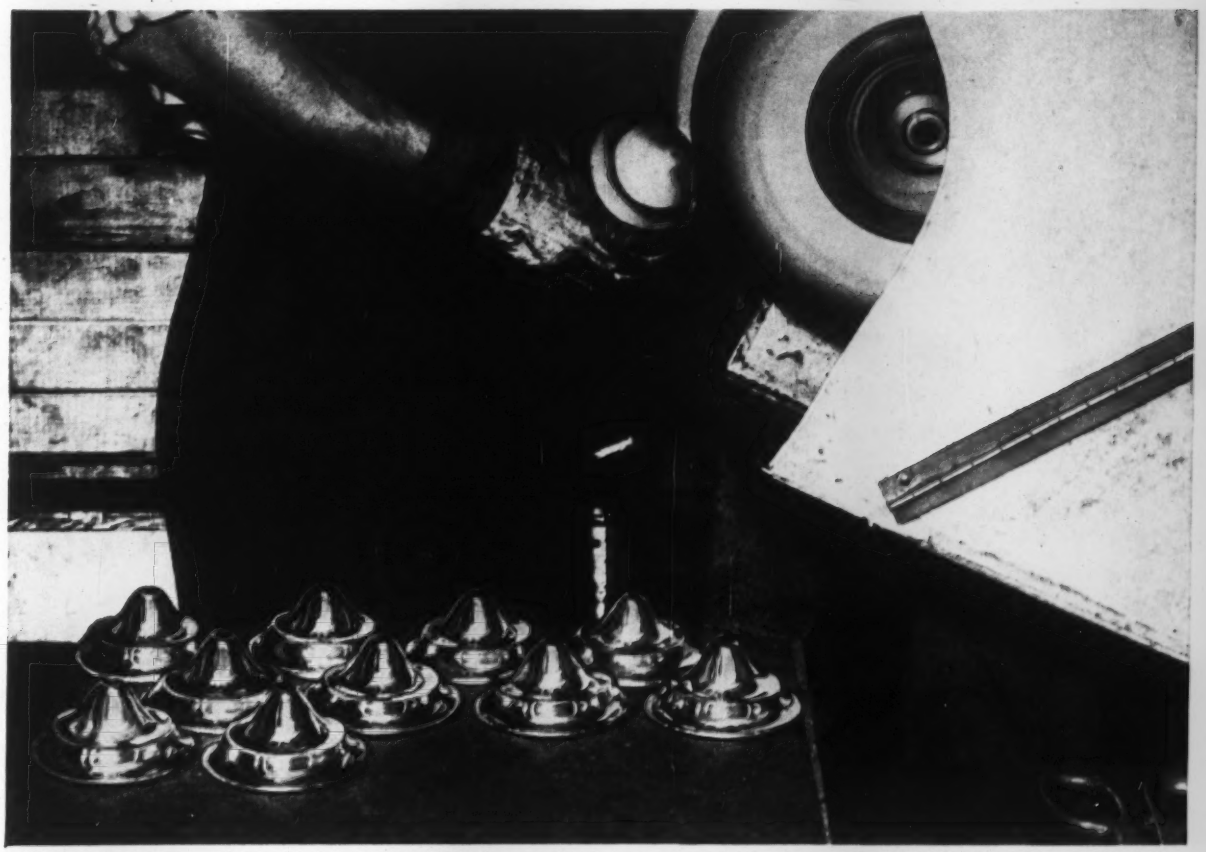
To you who know and have dealt with Read Standard, the merger means simply this . . . extensive research and development not only along present but completely new lines . . . broadened engineering, service and sales staffs to better handle your needs . . . and improved manufacturing facilities. As in the past, Read Standard will maintain office and plant operations at its location in York, Pa. Theodore F. Freed will be Vice President and Divisional Operations Manager of this Division.

To you whom we have served in the past, we wish not only to express our sincere appreciation but to affirm our policy. The prime objective of this Corporation is to make available to you the very best equipment and services that the ingenuity, modern research and manufacturing facilities of our combined operations can provide.

CAPITOL PRODUCTS CORPORATION

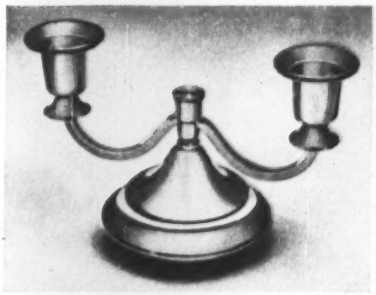
Eugene Gurkoff

Eugene Gurkoff
President



THE BASE of a Huntercraft Candelabra Model 8008 (shown below) requires, with Formbrite, only a finish buff. The base is formed in two drawing operations. The deeper drawn candle cups, also of Formbrite, need only a light cutting with Tripoli and a finish buff.

It's easy to get a jeweler's finish with Formbrite



HUNTERCRAFT Table or Wall Candelabra Model 8008, one of 30 fine brassware items in the line of Huntercraft Originals.

"Formbrite cut polishing cost and time dramatically—was a major factor in keeping our small business alive . . . and growing," says Ralph E. Hunter of Huntercraft.

THE production of Huntercraft Originals—now a nationally distributed line of fine brassware—has grown from a basement hobby to a thriving new business in less than 5 years.

The Hunter Machine Service Company of Racine, Wisc., began manufacturing Huntercraft Originals on a commercial scale in 1951, using ordinary soft forming brass. To get the gleaming jeweler's finish required, polishing time and costs were high. In fact, they were so high that the young company found it impossible to bring their prices into line with competition.

In 1953, they tried Formbrite®, Anaconda's superfine-grain drawing brass. The polishing bottleneck was broken and production soared—unit costs went way down. According to Ralph E. Hunter, owner and president of Hunter Machine Service Co., Formbrite was a major factor in keeping the company alive and enabling it to go on to become a stable, growing business. The finish obtained so easily on Formbrite, he adds, is superior to that achieved on ordinary drawing brass.

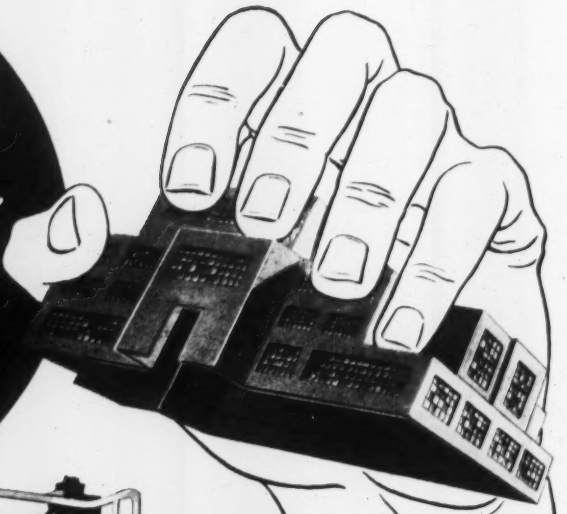
Formbrite is a premium product at a nonpremium price. Find out for yourself how its superfine-grain excellent drawing properties, strength, and scratch-resistance can help you make a better product at lower cost. Write for Publication B-39. Better yet, ask for a sample or a trial batch. Address: The American Brass Co., Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 6622

Formbrite **SUPERFINE-GRAIN DRAWING BRASS**

an ANACONDA® product

made by The American Brass Company

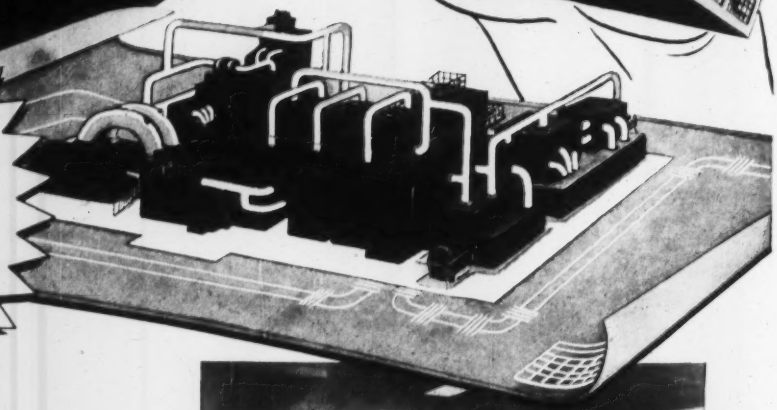
ENGINEERING at Pittsburgh Piping



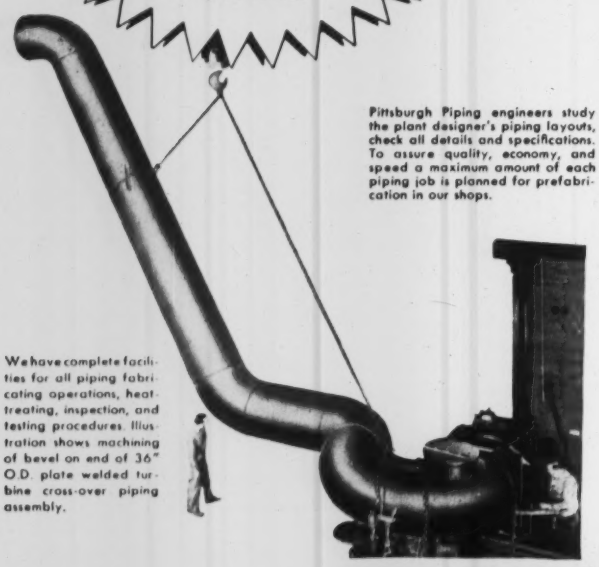
another P. P. & E. service which contributes to

Improved

HIGH-TEMPERATURE HIGH-PRESSURE PIPING



Pittsburgh Piping engineers study the plant designer's piping layouts, check all details and specifications. To assure quality, economy, and speed a maximum amount of each piping job is planned for prefabrication in our shops.



We have complete facilities for all piping fabricating operations, heat-treating, inspection, and testing procedures. Illustration shows machining of bevel on end of 36" O.D. plate welded turbine cross-over piping assembly.

We assume responsibility for every phase of a piping job — from blueprint through erection. Our engineers are specialists — thoroughly experienced in the theoretical and practical aspects, as well as in the code and insurance requirements, of high-temperature, high-pressure piping.

PRODUCTS AND SERVICES

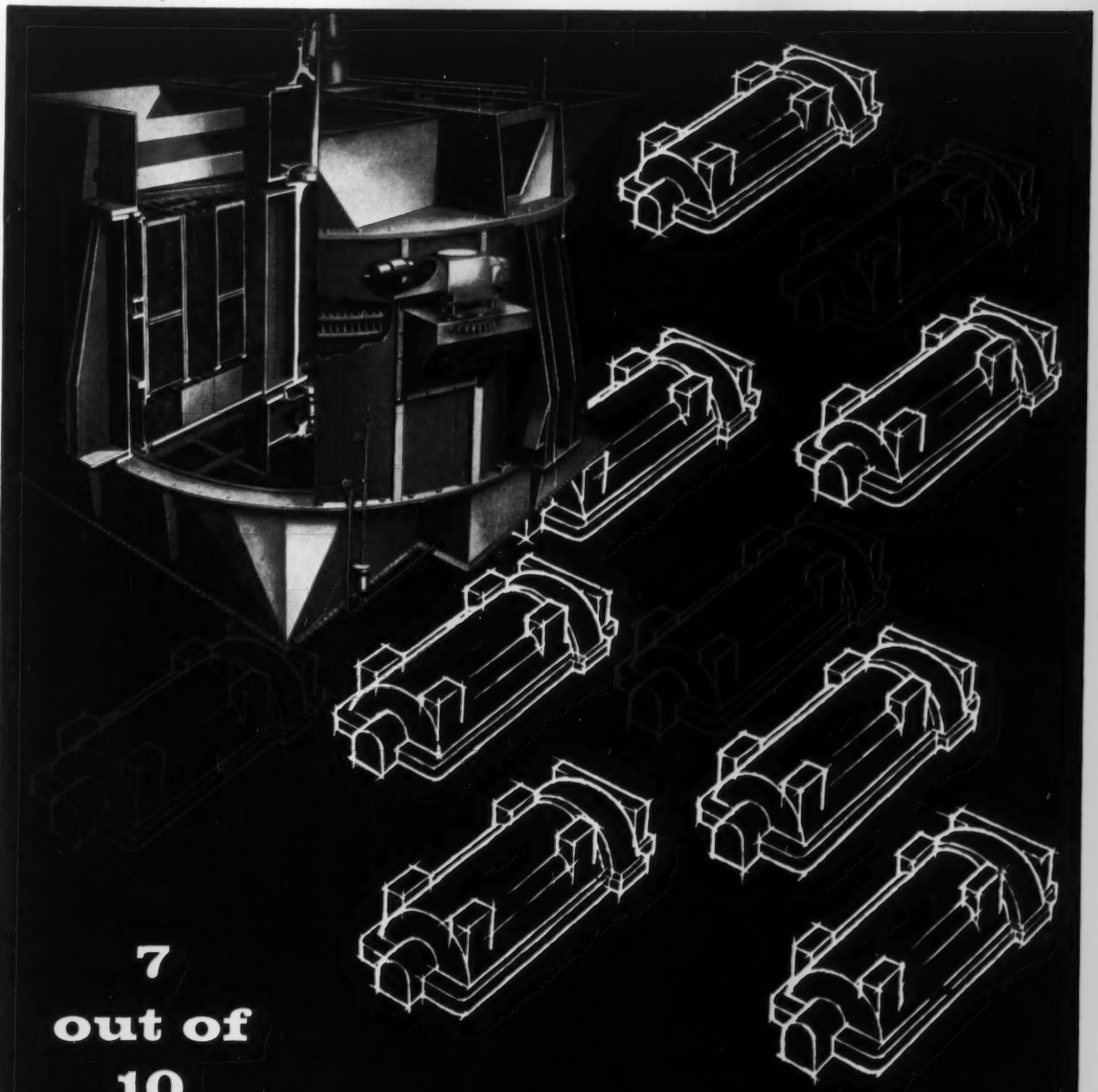
Carbon Steel Piping	Forged Piping Materials
Cast Iron Fittings	Headers
Cast Steel Fittings	Manifolds
Chrome-Moly Piping	Pipe Bends
Copper Piping	Stainless Steel Piping
Corrugated Piping	Van Stoning
Creased Bends	Welded Assemblies
Expansion Bends	Welded Stainless Steel Tubing
Flanges	Welding Fittings

PP-21

Pittsburgh Piping AND EQUIPMENT COMPANY
158 49th Street — Pittsburgh, Penna.
CANADA: CANADIAN PITTSBURGH PIPING, LTD.
835 BEACH ROAD—HAMILTON, ONTARIO

OFFICES IN PRINCIPAL CITIES

Atlanta	Whitehead Building
Boston	10 High Street
Chicago	Peoples Gas Building
Cleveland	Public Square Building
Hollywood	1828 North Alexandria Ave.
New Orleans	P. O. Box 74
New York	Woolworth Building
Syracuse	113 So. Salina Street
Toronto	68 Yonge Street



7 out of 10

air preheater installations are Ljungstrom®

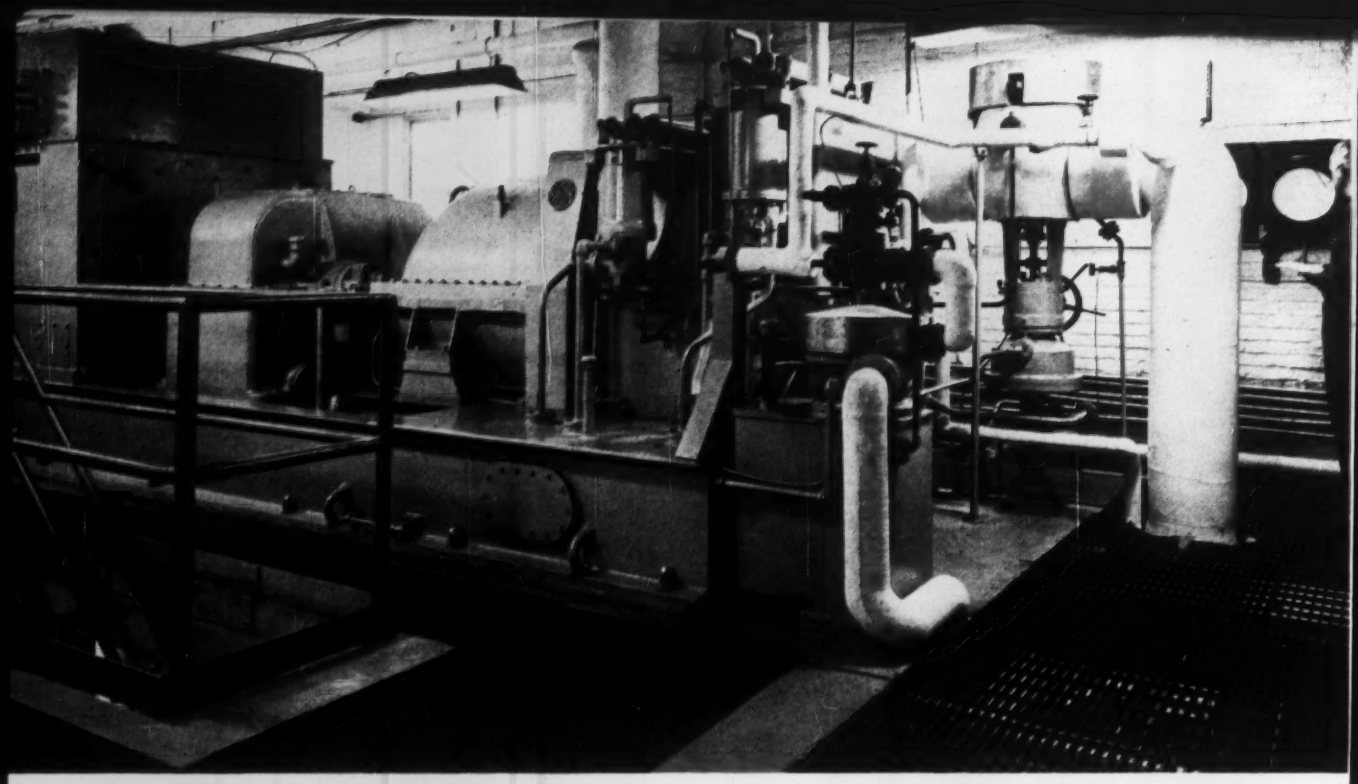
Advantages of the Ljungstrom Air Preheater

- Size for size, recovers far more heat than any other type.
- Reduces fuel consumption. Permits use of lower grade fuels. Increases boiler output and reliability.
- Eliminates cold spots . . . keeps corrosion to a minimum.
- Easier, faster to clean and maintain.
- Requires far less supporting steel and is quickly erected.

MINIMUM MAINTENANCE is one of the many important reasons. More complete combustion of fuel results in far less slagging, and gases entering dust-recovery units are cleaner. There's less corrosion. Insertion of new elements can be done in as short a time as four hours. You can even inspect the Ljungstrom through a built-in port while the unit is in operation.

For the interesting full story, send for a free copy of our 38-page manual.

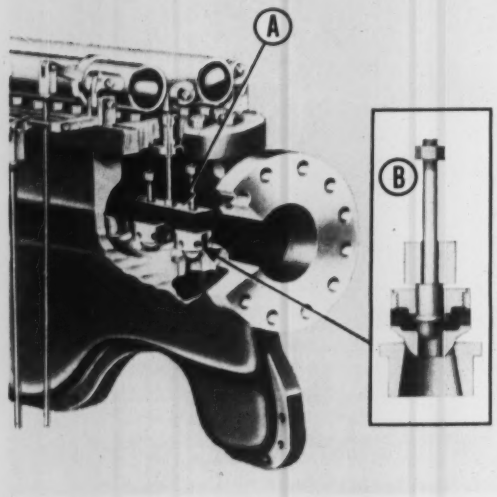
The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.



1500-kw General Electric steam turbine-generator installed at Foster Paper Company, Utica, New York.

General Electric's simplified valve gear offers more efficient turbine governing

DESIGN FEATURES PROVIDE CLOSE CONTROL, EASY MAINTENANCE



A. SIMPLIFIED BAR-LIFT arrangement of poppet-type valves has few parts, requires less maintenance.

B. DOUBLE-LIFT VALVES used on G-E high-speed turbines are a valve-within-a-valve arrangement. This means that the force required to open a valve is reduced allowing closer speed control over process operations.

*In Canada, contact Canadian General Electric, 107 Park St., Peterborough, Ont.

Here's another answer to requirements for safer, surer high-speed turbine operation. General Electric's simplified sectional valve gear mechanism offers more efficient governing and an improvement in heat-cycle efficiency.

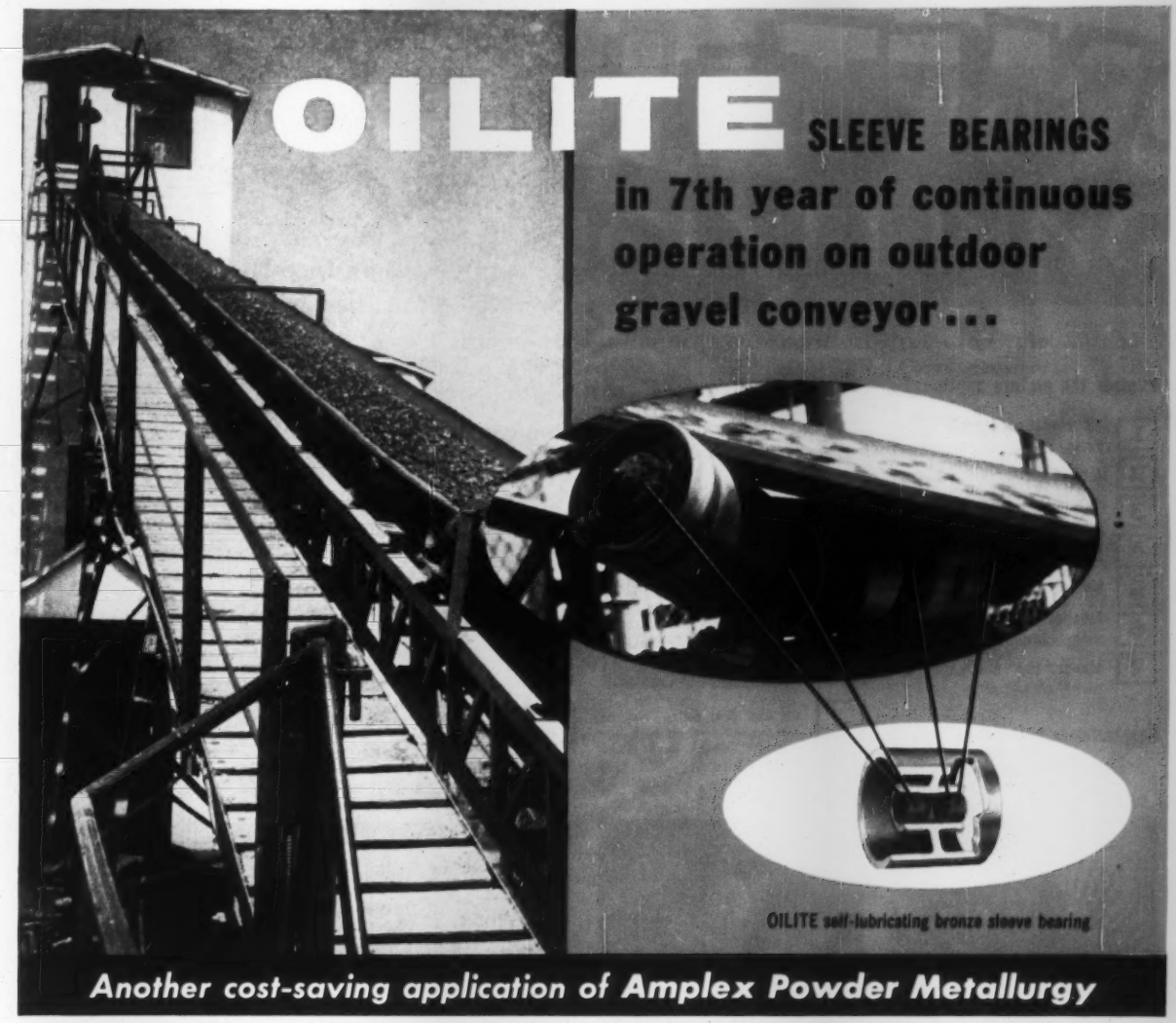
SIMPLICITY OF DESIGN and easy maintenance are provided by a bar-lift arrangement of poppet-type valves, each of which supplies steam to part of the nozzle area. As less flow is required, these valves are successively closed to keep the nozzle area in proportion to the steam required. The result is more accurate control of steam flow and reduced throttling losses.

INCREASED GOVERNING EFFICIENCY is also provided by the best combination of valves and seats. Single- or double-poppet valves and angle or venturi seats are available to meet your specific requirements. Nozzle area can then be matched with the proper valve combination to obtain uniform horsepower gradient.

These simplified valve gear components are still another example of the sound engineering built into every General Electric high-speed turbine. For complete information, contact your nearest General Electric Apparatus Sales Office*, or write for bulletin GEA-6232, General Electric Company, Section 241-9, Schenectady, New York.

Progress Is Our Most Important Product

GENERAL ELECTRIC


OILITE SLEEVE BEARINGS
in 7th year of continuous operation on outdoor gravel conveyor...
OILITE self-lubricating bronze sleeve bearing
Another cost-saving application of Amplex Powder Metallurgy

No seals protect these OILITE bearings from sand, gravel, grit. On the two center rollers, no additional lubrication is possible. Yet this OILITE-equipped outdoor conveyor has been in continuous operation under extreme weather conditions for seven years—*without replacing one OILITE bearing.*

That's some record! J. Cooke (Concrete Blocks) Ltd., of Aldershot, Ontario, one of Canada's largest producers of concrete blocks, operating twenty of these sand and gravel conveyors, has proved the long wearing, money saving qualities of OILITE bearings.

No wonder all twenty conveyors are 100% OILITE equipped. The company says, "We wouldn't use any other kind."

What interests you? Longer product life—greater efficiency—lower cost? All three? Maybe Amplex has the answer.

Write for detailed information about Amplex powder metal components—OILITE Bearings, Parts, Filters. Or call your nearest engineering representative listed in the yellow pages under "Bearings—OILITE."

Representatives and dealers located in principal cities in United States and Canada.

A CHRYSLER OILITE PRODUCT

Only Chrysler Makes **OILITE**

AMPLEX DIVISION

CHRYSLER CORPORATION • DETROIT 31, MICHIGAN

Bearings • Finished Machine Parts • Permanent Metal Filters • Friction Units

Ferrous and Non-Ferrous Metals

New 52-page OILITE Engineering Manual supplies engineering data and application information on OILITE powder metal bearings, parts and filters. Write on your letterhead for Manual E-56. Address: Dept. 2E.

METAL QUIZ

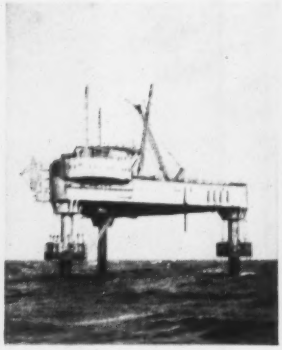
Each of these problems was solved successfully with an Inco Nickel Alloy
Can you tell which one proved to be the answer?

Number the picture captions!

1. **"S" Monel** hard-grade nickel-copper cast alloy
2. **Inco Nickel**
3. **"K" Monel** age-hardenable nickel-copper alloy
4. **Inconel** nickel-chromium alloy
5. **Monel** nickel-copper alloy
6. **Inconel "X"** age-hardenable nickel-chromium alloy
7. **Monel "403"** non-magnetic nickel-copper alloy

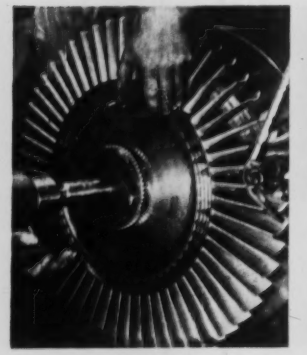
See answers below

☐ **Oil well drill collar** — Needed: non-magnetic metal with high strength. Which Inco Nickel Alloy . . . ?



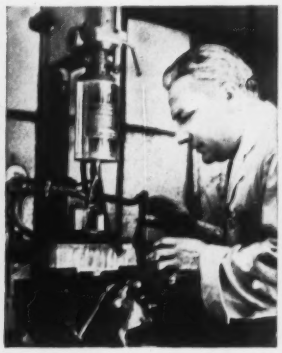
☐ **Radar platform "leggings"** — Needed: resistance to abrasion and marine corrosion. Which Inco Nickel Alloy . . . ?

☐ **Jet engine flame tube** — Needed: oxidation and corrosion resistance at jet engine temperatures. Which Inco Nickel Alloy . . . ?

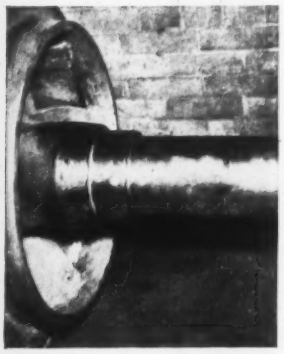


☐ **Gas turbine blades** — Needed: hot strength up to 1500°F., low coefficient of expansion. Which Inco Nickel Alloy . . . ?

☐ **Submarine cable sheathing** — Needed: non-magnetic metal resistant to marine corrosion. Which Inco Nickel Alloy . . . ?



☐ **Ultrasonic drill** — Needed: high magnetostrictive ability to produce ultrasonic vibrations. Which Inco Nickel Alloy . . . ?



☐ **Shaft sleeve for salt water pump** — Needed: extra-hard casting alloy that resists corrosion. Which one . . . ?

You may take this kind of quiz *again* . . . and soon! *Your* design may require a metal that resists corrosion . . . or wear . . . or high temperatures. Or one that meets some destructive *combination* of conditions.

Then look into the Inco Nickel Alloys. First step: send for "Standard Alloys for Special Problems." This fact-filled booklet describes the properties of many useful metals . . . shows just the kind of problem each has solved. Write for a copy . . . do it *now!*

*Trademark of The International Nickel Company, Inc.

THE INTERNATIONAL NICKEL COMPANY, INC.
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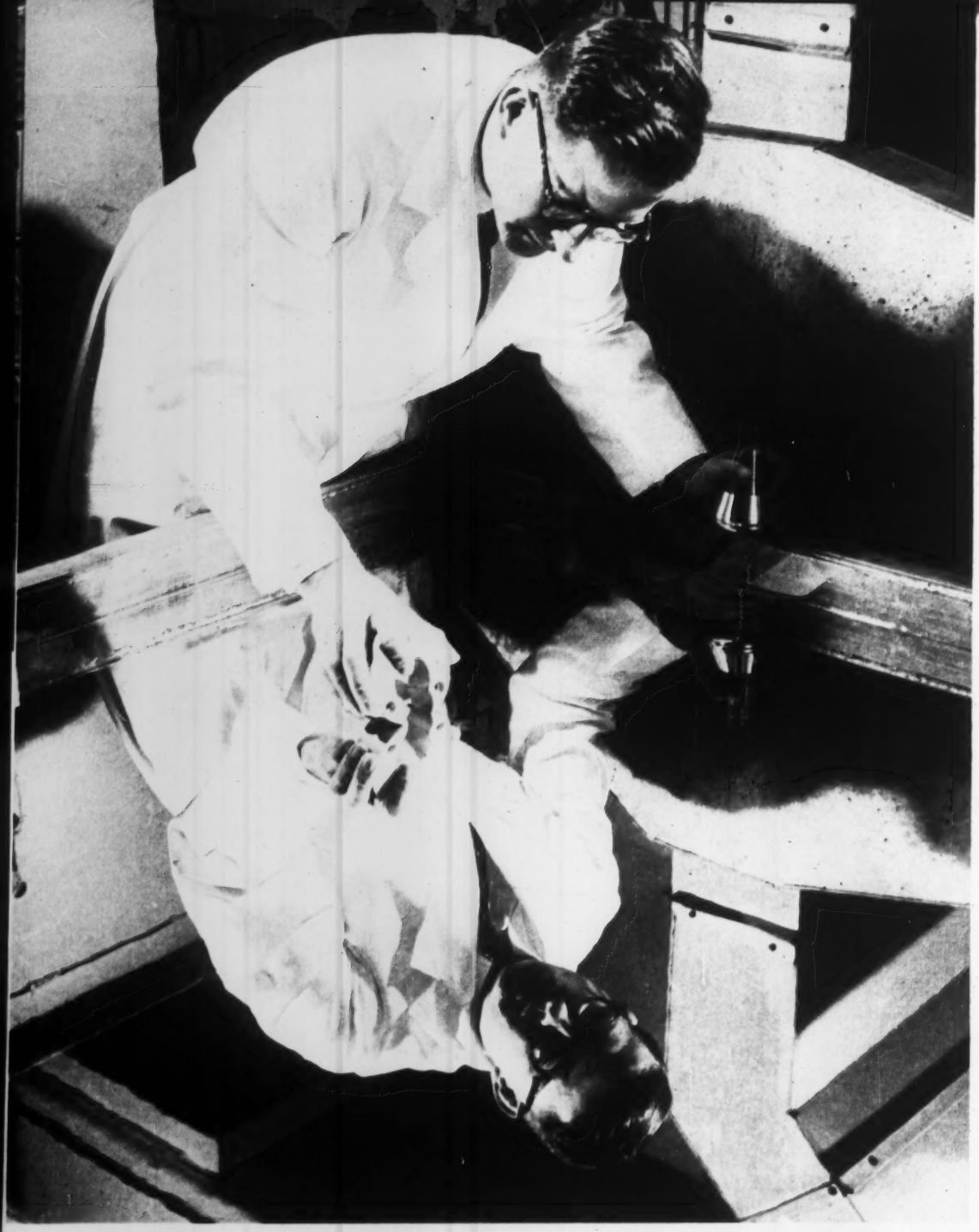

A Revolutionary Superstrong Permanent Magnet . . .

. . . has been developed by General Electric Company researchers. Dr. T. O. Paine, leader of the G-E research team that developed the new permanent magnet, is shown here collecting submicroscopic iron particles with a conventional magnet from this pool of liquid metal at the company's Instrument Department Laboratory in Lynn, Mass. This equipment produces more than a million billion particles per second which are later pressed to form a magnet potentially twice as powerful as any in existence today. Further details may be found on page 169 of this issue.

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MECHANICAL ENGINEERING

George A. Stetson, *Editor Emeritus*
J. J. Jaklitsch, Jr., *Editor*

Nuclear Congress and Unity

EVER since the successful splitting of the atom a chain reaction of many dynamic developments has occurred. Besides the weapons program, the peaceful uses of the atom—as a power source for the generation of electricity, as a new mode of propulsion, and the use of by-products of the atom—have stimulated the imagination of engineers and scientists all over the world. Additionally, the atom seems to be fulfilling one other important function—true unity of purpose both within the engineering profession and within the larger field of science and technology. This unity of purpose will be forcefully demonstrated next month, March 11 to 15 to be exact, when the 1957 Nuclear Congress gets under way in Convention Hall in Philadelphia, Pa.

The main purpose of the Congress, as co-ordinated by Engineers Joint Council, is to foster a free exchange of knowledge, information, and ideas between engineers and scientists in all fields of technology; among leaders in industry and management; and between management and engineers and scientists. The Congress is also designed to reduce the demands on the time of individuals by bringing into one meeting the latest information and exhibits from all fields of nuclear science, engineering, and management covering creation and utilization of atomic energy for peaceful purposes.

The Congress will include the following four major elements:

The Second Nuclear Engineering and Science Conference, co-ordinated by Engineers Joint Council on behalf of 21 engineering and scientific societies, which will include 150 technical papers during a four-day program dealing with all phases of nuclear operations from mining of ores through measurement of radioactivity in the atmosphere and disposal of radioactive wastes. Emphasis will be on new developments of potential value to civilian industry throughout the world, especially in the fields of metallurgy, chemical processing, and mechanical and power applications.

The International Atomic Exposition, sponsored by the American Institute of Chemical Engineers in co-operation with the American Society of Civil Engineers, the American Institute of Mining, Metallurgical, and Petroleum Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, which will display the atomic industry's latest developments.

The Fifth Conference on Atomic Energy in Industry, sponsored by the National Industrial Conference Board, which will discuss factors involved in the setting up of industrial atomic laboratories for research and development. It will also cover aspects of nuclear operations of concern to management, including discussion of the latest developments in atomic energy as they affect the business and economy of the country.

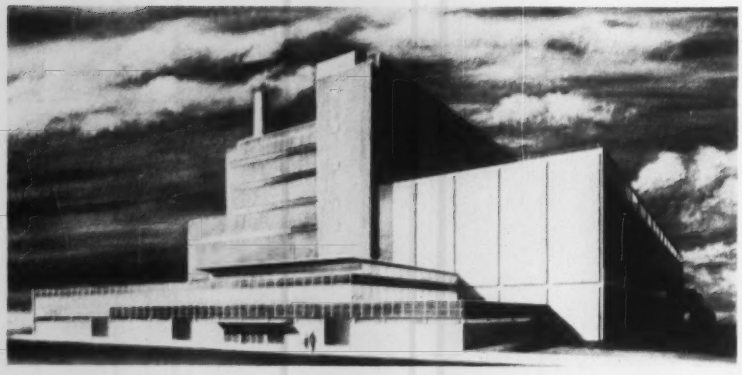
The Fifth Hot Laboratories and Equipment Conference, sponsored by the Hot Laboratories Committee of the Oak Ridge National Laboratory, which will deal with the operation and development of equipment for atomic-energy laboratories.

Besides its co-operation with AIChE in the Atomic Exposition, ASME's position in the nuclear field will be evidenced by the major role it is playing in the Conference portion of the Congress. Of the 150 papers on the program, 39 are being sponsored by ASME. The ASME papers will consider such topics as plant-containment concepts and design, primary coolant systems, plant components small and large, new limits and codes for radiation protection, radiation processing, reactor core design, reactor control and simulators, and heat-transfer problems. A detailed listing of the ASME papers to be delivered at the Conference can be found in the "ASME News" elsewhere in this issue.

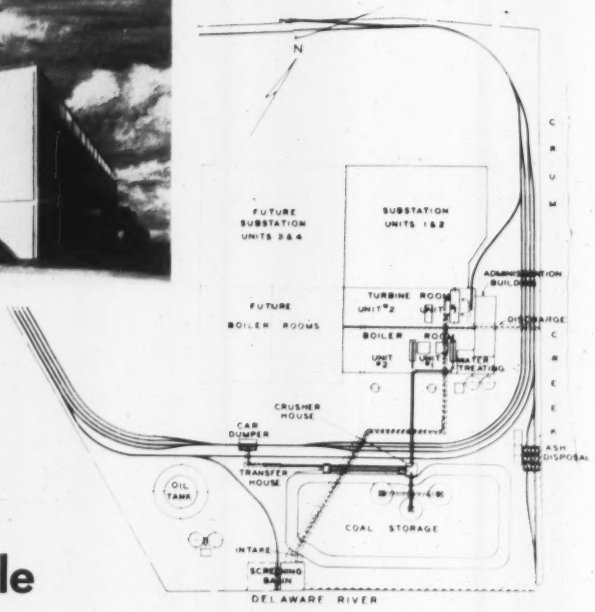
ASME members and mechanical engineers, in general, should find much of interest in this and other portions of the Conference program and Congress, and it is urged that all who can attend. The field of atomic energy is growing rapidly and changes in the field are occurring even more rapidly. Hence an all-embracing program such as this one provides, in a short period, a place where specialists and industrial leaders can bring themselves up to date on new developments in the atomic field.

Indeed, it isn't often that engineers are able to attend three integrated conferences and an exposition on atomic energy in the space of a week. And the EJC is to be congratulated for its work in co-ordinating so ambitious a task.

Thus the Congress, besides expediting the dissemination of information on new atomic developments and reporting progress in the civilian uses of atomic energy, is serving to provide the stimulus for greater unity within the engineering profession. It is to be hoped that, with the Congress as an example, unity in other areas of the engineering profession will be achieved as well.



Architectural conception of Eddystone plant of Philadelphia Electric Company. Designed for supercritical steam conditions, the plant will operate at 5000 psig and 1200 F.



Plot plan of Eddystone Station. Housed on a 100-acre tract, the plant will be of the fully housed type.

Eddystone Plant Employs Supercritical-Pressure Cycle

In the summer of 1955 the Philadelphia Electric Company announced plans to construct the world's most efficient steam-electric station operating on a supercritical-pressure double-reheat cycle. This article contains high lights from three papers contributed by the Power Division and presented at the 1956 ASME Annual Meeting in New York, N. Y. The papers, which will be published in full in Transactions of the ASME, are: "Engineering the Eddystone Plant for 5000-Psig, 1200-F Steam," by J. H. Harlow, Philadelphia Electric Company (56—A-165); "The Eddystone Superpressure Unit," by C. B. Campbell, C. C. Franck, Sr., and J. C. Spahr, Westinghouse Electric Corporation (56—A-156); and "Engineering the Eddystone Steam Generator for 5000-Psig, 1200-F Steam," by E. M. Powell, Combustion Engineering, Inc. (56—A-164).

THE supercritical-pressure steam cycle offers the possibility of substantial improvements in the thermal efficiency of steam-electric plants and consequently has long interested both the designers and users of power-plant equipment. The idea for the Eddystone Plant of the Philadelphia Electric Company came into being a little more than two years ago when an agreement was reached among Combustion Engineering, Inc., Westinghouse Electric Corporation, and Philadelphia Electric Company to co-operate in the design and construction of a supercritical-pressure unit. Originally planned to have a capacity of 275,000 kw, the boiler-turbine-generator unit was subsequently increased to 325,000 kw. Throttle steam conditions are 5000 psig, 1150 F with two reheats to 1050 F, but the design contemplates throttle temperature of 1200 F after a period of operation at the lower initial temperature.

The plant is housed on a 100-acre tract, including 1400-ft frontage on the Delaware River, in Eddystone, Pa., just east of Chester and a few miles from the Philadelphia International Airport. It will be of the fully housed type, the turbine room being enclosed in hollow tile and glass sash and the boiler plant with uninsulated corrugated aluminum siding. Although Philadelphia Electric Company has recently built two semioutdoor power plants, a thorough analysis of the economics and operating convenience of the enclosed design tipped the balance in favor of the latter. Normal fuel for the station will be bituminous coal shipped by rail. A live storage pile of sufficient capacity to operate two units in the plant for three days will be provided.

In selecting the size, steam conditions, and heat cycle or Eddystone No. 1, the criterion was to take advantage of the most recent technological advances in so far as they could be reasonably supported economically. The design pressure of 5000 psig establishes a new high mark in the development of the steam plant cycle, as does the 1200-F throttle temperature. With such advanced steam conditions it is generally agreed that large-capacity units must be installed if full thermodynamic

advantage is to be achieved. In addition to the supercritical pressure, the very high temperature, and two reheats, a great deal of attention has been directed to other parts of the cycle in order to capture all available heat units. To this end the pressure level of each feedwater heater, the use of drain coolers and heater-desuperheater zones, the location of heater drains, and the disposition of pump and turbine shaft-seal drains, among many other items, have been studied carefully. Among innovations being tried in the plant is an arrangement for using lowest pressure bleed steam to temper combustion air and for using a low-level economizer to heat condensate, thus lowering the stack temperature to about 200 F. The end result has been to produce a calculated heat rate at nominal rating of load and steam conditions and with 1-in. back pressure of 8016 Btu per net kwhr.

Over-All Plant Cycle

The over-all plant cycle is illustrated opposite. This simplified diagram shows the various components of the boiler in rectangular blocks to the left and the various components of the turbine represented by triangular blocks to the right. The pumps are circles.

Starting at the condensate pump, the feedwater is pumped through heaters to the deaerator. From the deaerator the low-pressure feedwater pump picks up the water and delivers it through the high-pressure feedwater heaters to the intermediate-pressure and high-pressure feedwater pumps. After leaving the high-pressure pump the feedwater passes through an excess-pressure control valve and a feedwater-regulating valve. Between the two valves a portion of the water is tapped for desuperheater use. The excess-pressure valve is installed to provide a constant differential of about 30 psi across the feedwater valve. This will reduce substantially the amount of adjustment required of the feedwater-control valve and of the desuperheater spray-control valves.

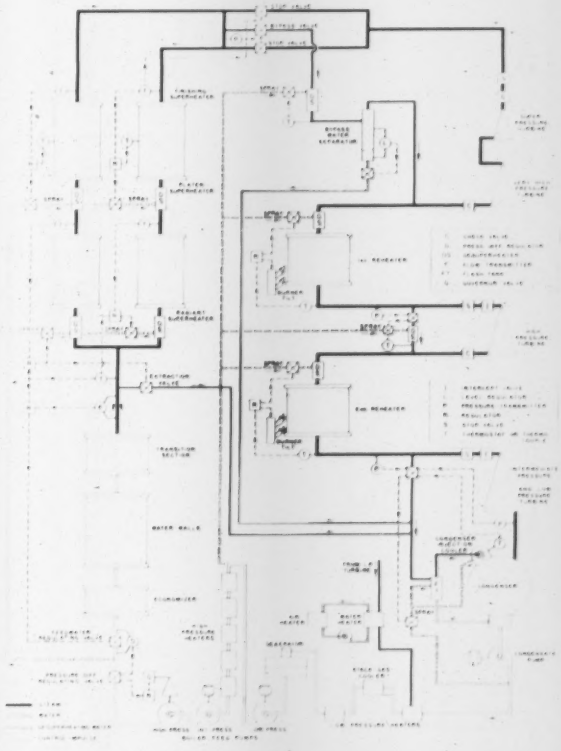
After passing the feedwater valve the water enters, first, the economizer, second, the waterwall portion of the boiler in the lower part of the furnace, and third, the transition section which is located in one of the zones of lower temperature. Steam leaving the transition section will be slightly superheated, being at a temperature of about 900 F. A temperature-measuring device at this point provides for feedwater-flow regulation.

Because there is no drum in the once-through boiler there is no level to use for feedwater control. Therefore, the feedwater regulation is obtained by adjusting water flow to steam flow in a manner similar to that used in the conventional three-element feedwater regulator but with a bias control depending upon the temperature at the outlet of the transition section. This part of the boiler, therefore, acts as a calorimeter to proportion water flow to firing rate.

From the transition section the steam passes through two superheater zones, the first being radiant surface in the walls of the furnace and the second being a finishing superheater made up of platens in the upper furnace cavity. The output temperature of each zone is controlled separately by desuperheater spray.

Between the boiler and the turbine the steam passes through boiler stop valves. The primary function of these valves is associated with starting the boiler, but secondarily they are equipped with pressure and temperature-sensitive controls to close in the vent of too low steam temperatures or too low steam pressure, thus providing protection for the turbine.

In starting a once-through boiler the scheme is to pump water through the system at the rate of about one-third maximum flow. This is the minimum flow considered adequate for insuring sufficient circulation through all tubes in heated surfaces. The turbine, obviously, will not be in operation, so in order to make this possible, by-pass valves are installed as shown. The valves discharge into a by-pass separator. In starting, the one-third flow is first established using a by-pass and then the fire is lighted. As the temperature increases, some of the water flashes in the separator and is conveyed through the high and low-pressure turbine by-passes and the reheaters to the condenser by way of a condenser-injection cooler. Thus the reheaters are prevented from overheating. The hot water which does not flash drains from the separator to the condenser. When a suitable temperature has been attained, there will be no drain and only steam will leave the separator. The stop valves may then be opened and the turbine started. As the turbine comes up in load, the pressures at various points in the turbine are increased. This automatically closes the various turbine by-pass valves. In the event of tripping, these by-pass valves will open automatically. Thus a considerable measure of excess-pressure protection will be provided and the burden on the safety valves will be greatly reduced.



Over-all plant flow diagram. Components of boiler are indicated by rectangular blocks at *left;* turbine components are represented by triangular blocks at *right.*

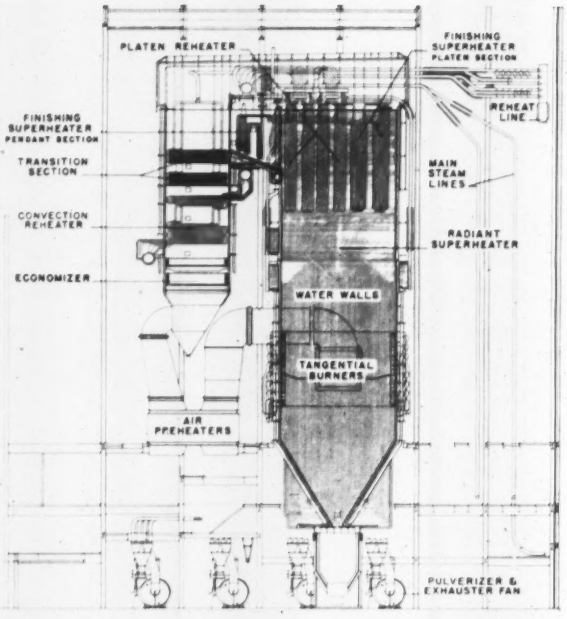
As illustrated, a by-pass is installed from the outlet of the transition section directly to the condenser. Any water flowing in this circuit by-passes all superheater and reheater surface while providing cooling in the lower furnace. This device may be used during the start-up cycle to increase steam temperature by altering the normal balance in the requirements of water heating and steam heating. It also can be used during hot starts when it would be dangerous to circulate water through hot superheaters and main steam piping.

Steam Generator

The steam-generating unit for Eddystone No. 1 is designed to deliver steam to the turbine at a pressure of 5000 psig, at a temperature of 1200 F, and at a rate of 2,000,000 lb per hr. There are two stages of reheat both at 1050 F. To generate steam at supercritical pressure the once-through type boiler is a necessity, and in this instance the European experience gained by Sulzer Brothers of Switzerland in designing once-through boilers is combined with the American experience of Combustion Engineering, Inc., in the design of large utility power boilers.

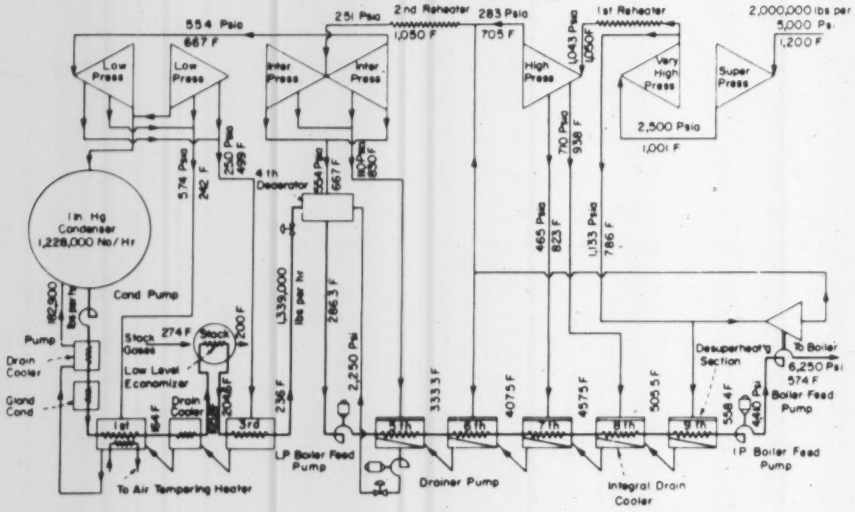
While there has been nothing in Europe which exactly duplicates the conditions for Eddystone, there has been considerable experience with advanced steam cycles as applied to once-through boilers. The basic principles and operating procedures are so similar as to require moderate extrapolation. The design of Eddystone has been based on this background plus experience with high-pressure controlled-circulation units utilizing small-diameter tubing.

The design of this unit follows the general pattern of two-furnace units which have been developed for capacities of from 200 mw and up. In so far as possible it will be made up of standard components with which there have been many years of successful operating experience. The two notable exceptions are the once-through flow of water through the pressure parts and the design of superheater for the high steam temperature with high pressure.



Cross section of steam generator. This unit consists of two identical furnaces of the dry-bottom type, each fired with tangential burners located in the four corners.

The boiler unit consists of two identical furnaces of the dry-bottom type, each fired with tangential burners located in the four corners. Since there are two reheaters in this cycle, one can be associated with each furnace. In that way each can be controlled independently by burner tilt, thereby avoiding the necessity for spray desuperheating. This will make it possible to obtain the maximum cycle efficiency and at the same time provide constant reheat temperatures over a wide range of ratings. Steam temperature to the turbine will be



Schematic arrangement of feedwater-heater cycle. Nine stages of feed heating provide 574 F water for boiler.

regulated by proper proportioning of water flow through the heating surfaces.

Full consideration has been given in the furnace design to past operating experience with coals which will be available to this plant. Sufficient cooling has been provided to avoid sticky ash deposits in the closely spaced convection surfaces. The walls are completely covered with tangent tubes with no exposed refractory to facilitate cleaning with wall blowers.

In the design which was finally adopted, the heating surface for the high-pressure circuit is the same in each half of the unit. Feedwater enters the economizer and flows upward through tubes cooling the side walls of the convection pass. It is collected in a header on each side wall and directed through piping to the entrance to the tube circuits covering the lower furnace walls. These up-and-down circuits terminate in two headers located at the center of the front wall. The water which is collected at this point is then taken through piping to the convection surface at the top of the rear pass through tubing, forming cooling for the front and rear walls of the convection pass. The transition from water to steam, discussed earlier, takes place in this zone of low gas temperature and reduced heat transfer. Two separate circuits have been maintained through this point for each furnace, making a total of four circuits, each with its own independent control system to maintain uniform metal temperatures and match the water flow to heat absorption as required.

Each circuit is then subdivided into two through piping and then directed to the radiant superheater forming the walls of the upper third of the furnace where it will pass through a series of horizontal tube circuits up to the roof. Final superheating is done in the platens in the upper front corner of the furnace and the convection pendant loops just beyond the furnace outlet. In this way superheating to 1200 F has been done in a zone of minimum gas temperature compatible with the steam temperature from the standpoint of heat transfer, thereby resulting in the minimum metal temperature. Heating the tubes to around their entire circumference also serves to reduce the temperature stresses in the tube wall. These principles were considered most important to insure the successful operation with this advanced cycle and the new alloys which are associated with it. The division into eight individually controlled circuits was justified by the same reasoning.

There is a complete reheater associated with each of the two furnaces. Steam from the turbine enters at the rear and is heated in two stages—first by convection in the rear pass immediately above the economizer, and then by radiation in the platens located at the top of the furnace. The two reheaters are substantially the same, modified slightly to suit the difference in steam temperatures from the turbine.

A pilot supercritical-pressure boiler is in operation at the Kreisinger Laboratory of Combustion Engineering in Chattanooga, Tenn. Steam is generated at 5000 psig, 1200 F in a single-circuit boiler which is a scaled model of the Eddystone unit, containing the same materials and substantially duplicating pressures, temperatures, and coefficients of heat transfer. The same water-purifying system is used and supplies water to the boiler of the same purity and oxygen content. Steam from the boiler is passed through a simulated turbine consisting of several stages in order to study deposit formation as steam expands. A contaminating vessel is located between the boiler and simulated turbine to study the solubility of various materials and determine the deposit pattern in the turbine.

Turbine Generator

The superpressure turbine is being designed and built by Westinghouse Electric Corporation for a rating of 325,000 kw. The regenerative cycle is employed with eight extraction stages from the turbine and an interposed stack gas cooler. The turbine is of the cross-compound type and consists of several higher pressure elements operating at 3600 rpm and an 1800-rpm double-flow low-pressure element. The main flow of steam from the turbine stop valves is, in series, through the superpressure (SP) and the very high-pressure (VHP) elements, the first reheat stage, the high-pressure (HP) turbine stages, the second reheat stage, and finally through the intermediate (IP) and low-pressure (LP) turbines to the condenser.

Steam at 5015 psia and 1200 F is supplied through four inlet lines, each having its own stop and governing valve. Each of these inlets is connected to one of the four nozzle chambers which provide full circumferential admission to the first of a total of five impulse stages. The first stage only is velocity-compounded. This type of stage is used in order to extract the maximum possible energy, thereby effecting a maximum reduction in steam temperature. In spite of this, the temperature encountered at the exit of the first stage is approximately 1120 F at maximum steam flow. From the final SP turbine stage, steam exhausts at 2500 psia at which point the temperature is 1000 F.

The next main turbine component in series is that designated as VHP-HP, and in reality houses two complete and independent elements. At maximum flow, SP exhaust into the VHP element is at about 2500 psia and 1000 F. In turn, the VHP stages exhaust to the first reheater at 1133 psia and 790 F. Steam returning from the first reheater at 8 per cent reduced pressure but at 1050 F, then expands through the HP turbine stages to the second reheater system, at maximum flow pressure of 283 psia.

Steam returns from the first reheater through two 16-in. leads, each of which is equipped with a stop valve.

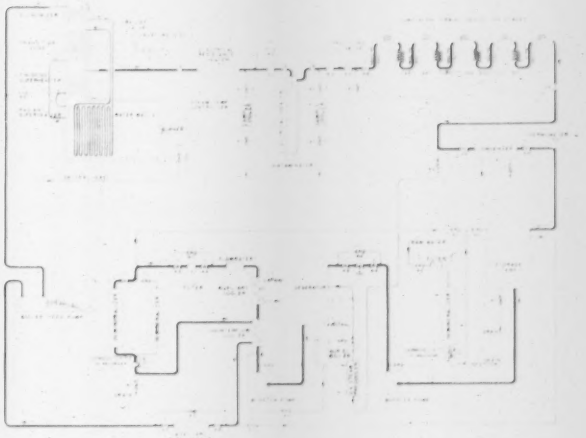
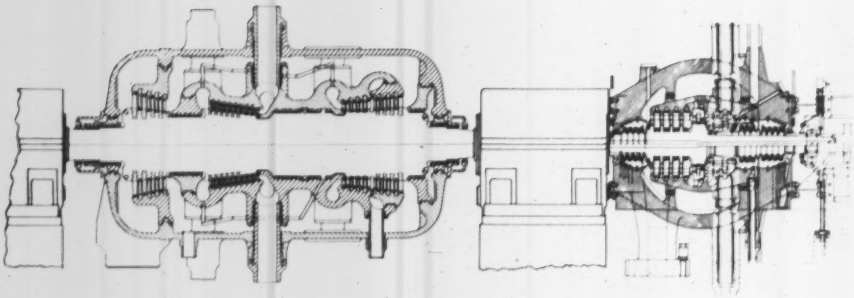
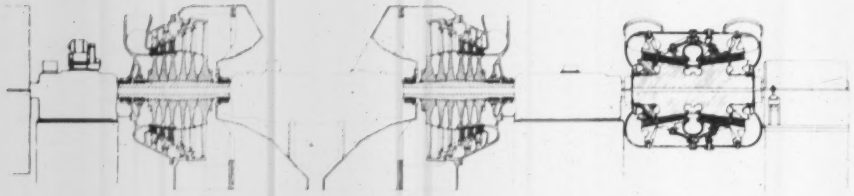


Diagram of Chattanooga test boiler, a pilot for Eddystone



Cross section of 3600-rpm turbine



Cross section of 1800-rpm turbine

These leads are then split to supply four 10-in. interceptor valves which are located on the turbine casing.

Steam from the second reheater returns to the IP turbine which, in connection with the LP turbine, comprises the 1800-rpm shaft. The double-flow design principle is used with steam admission at the center of the casing. This construction results in the most advantageous arrangement from considerations of the rotor forging and of the casing structure. The rotor is of the built-up type with the center core of the rotor forging of a material suitable for operation at the elevated temperatures encountered. The double-flow feature permits the use of a relatively small-diameter rotor lending itself to a practical forging of the chrome moly vanadium material required. While the stresses in this rotor are within conservative limits, rotor cooling in this critical area is applied.

Steam from the IP turbine element is exhausted through four 34-in-diam openings, two of which are located at the governor end of the IP turbine and two of which are located at the generator end of the IP turbine. This particular zone, which is at a pressure of 55 psia and a temperature of 665 F, provides the steam for the No. 4 heater which is of the deaerating type. Steam is extracted from both ends of the IP turbine exhaust through an equalizer pipe so as to balance the flow and pressure at this zone. The steam is returned to the IP element at a pressure of 251 psia and a temperature of 1050 F, through four 20-in. pipes. The inlet steam passes through four reheat stop valves and into the turbine through four interceptor valves mounted on the turbine base and cover. The interceptor valves are similar to those shown in connection with the VHP-HP turbine component.

The LP element is designed for high capability and good vacuum conditions which require that large exhaust annuli be provided to reduce the leaving losses to a minimum. The large physical size of the last row of blades, if applied in the conventional double-exhaust arrangement, would result in a composite LP turbine rotor which would be either beyond or tax the capacity of conventional crane-handling equipment, both at the manufacturing facility and in the power plant. In addition, the physical size and great weight would make handling during shipment a difficult problem. In order to reduce this weight, the LP turbine element is divided into two separate individual sections. This general arrangement of the LP turbine elements resulted from a study which indicated that rather insurmountable problems associated with foundation and condenser design would become inevitable with any other previously used turbine arrangements. Steam from the exhaust of the IP turbine enters the LP elements through connections which are located in the cylinder covers. The LP elements are provided with two extraction points for feedwater heating. The first point, which is at a pressure of 25 psia and a temperature of 500 F, furnishes steam for the No. 3 heater. It should be noted that the No. 2 heater does not receive extraction steam from the turbine but is fed by a stack gas heat exchanger. Provision is made, however, for a connection to the No. 2 heater extraction zone. The lowest pressure extraction zone provides steam at 5.7 psia at a temperature of 245 F. A part of this steam is utilized in the No. 1 heater. In addition, steam from this zone is utilized for air preheating purposes.

The SP element is connected in tandem with the VHP-HP component to drive the 3600-rpm generator which is rated 184,320 kva at 0.85 power factor with a hydrogen pressure of 45 psig. This 3600-rpm generator is of the inner-cooled type. As a result of the reduction in machine dimensions made possible by the very effective ventilation of the inner-cooled generator, the rotor forging diameter for this unit is only 37 in. This forging can be manufactured with greater ease and with greater assurance of uniformity than would be possible with a larger diameter. The design is basically more conservative because the mechanical stresses are lower.

The IP turbine is connected in tandem with the double-flow LP turbine to drive the 1800-rpm generator which is rated 231,680 kva at 0.85 power factor with a hydrogen pressure of 45 psig. This generator is the first inner-cooled type of machine to be designed for a speed of

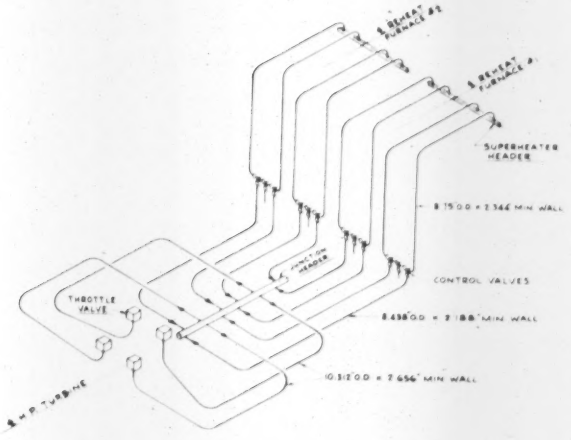
1800 rpm. By the use of this design, it is possible to reduce the over-all diameter of the rotor forging to 55 in. A three-piece rotor is being used with a hollow cylindrical center section which may be forged on a mandrel under the most advantageous conditions and lends itself to checking for metallurgical soundness.

Condenser

The unit will be served by a 150,000-sq-ft surface condenser designed to condense 1,288,000 lb of steam per hr and maintain a vacuum of 1 in. Hg abs with 200,000 gpm of 58 F river water passing through the tubes. Tubes of $^3/_4$-in. 18 bwg Admiralty metal are used, having a total length of 30 ft. The water boxes of the condenser are divided, but the twin tube bundles are arranged in a single shell which is common to the two low-pressure turbine exhaust casings. Tube sheets will be of muntz metal. Tubes will be rolled with an electric-limit-type tube roller. The condenser will be solidly supported with a rubber expansion joint at the turbine-exhaust connection.

With the exception of the deaerator, all of the feedwater heaters are of the closed type. All high-pressure heaters have integral drain coolers and those receiving high-temperature steam are provided with desuperheating zones to obtain the maximum rise of feedwater temperature. The heater shells are flanged in such a way as to be removable without disconnecting any major water or steam line. Tubes will be rolled in. The high-pressure-heater channel covers are of quadrant design and of the pressure-sealed manhole type. There are two independent lines of heaters, each line being capable of carrying about two thirds of the turbine's full load. All heaters are arranged horizontally.

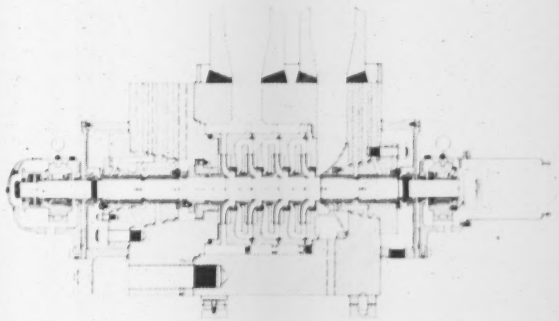
The urgency in this supercritical job for pure oxygen-free water with an absolute minimum of chemical treatment dictated the use of a deaerator. It is installed at the 55-psia bleed point with an additional connection to the second cold reheat line to provide a floor of 3 psig at flows below 30 per cent. Each deaerator is a single unit of the tray type.



Isometric drawing of main steam piping system. Dimensions are theoretical and will vary in accordance with dimensions of fabricated material.

Boiler Feed Pumps

The boiler feed pumps are arranged in a series of three: low, intermediate, and high pressure. Each develops somewhat more than 2000 psi at full load. At shut-off and at loads up to about one third of full load the low and intermediate-pressure pumps, operating without the high-pressure pump, will develop more than 5500 psi. The low and intermediate-pressure pumps are driven at constant speed by two-pole induction motors, respectively sized, 4000 hp and 4500 hp. The high-pressure pump is steam-turbine driven and therefore is capable of variable speed to satisfy the system requirements at above one-third rating. The feedwater pumps are in duplicate, each series of pumps being installed in one of the two lines of heaters. The low-pressure boiler feed pump is installed directly under the deaerator. It is a five-stage pump, employing double-suction first-stage impellers. At full load the available suction pressure is 75 psia and the discharge pressure is 2250 psi. The intermediate-pressure pump is a four-stage pump receiving its suction from the low-pressure-pump discharge by way of the high-pressure feedwater heaters. Its suction pressure at full load will be about 2150 psia and its discharge pressure about 4400 psia.



Section through high-pressure boiler feed pump. This is a six-stage pump receiving its suction directly from the intermediate-pressure pump and delivering feedwater to the boiler at the required pressure.

The high-pressure pump, a cross section of which is shown, is a six-stage centrifugal pump receiving suction directly from the intermediate-pressure pump and delivering feedwater to the boiler at the required pressure. It is so designed that, at less than one-third plant load, the feedwater may be pumped through it without danger to the pump or the pump drive. This pump is turbine-driven. The turbine receives steam from the first cold reheat and exhausts to the second cold reheat. Thus it is in parallel with the intermediate-pressure component of the main turbine, and the pressure available for its operation is the pressure drop through this component of the main turbine.

The high-pressure boiler feed pumps are turbine-driven with the turbine drive rated at 5000 hp and 5190 rpm when operating with steam conditions of 1110 psia, 790 F at inlet, and 290 psia at exhaust. Turbine design and materials are suitable for 1450 psig, 825 F at inlet, and 300 psig at exhaust. Normal operating conditions are anticipated to be 3530 hp, 4600 rpm with 1110 psia, 790 F at inlet, and 290 psia at exhaust.

SAFETY STANDARDS

By Cyril Ainsworth

Technical Director,

American Standards Association,

New York, N. Y.

We are entering an era when any engineer must be as well trained in safety as in any other phase of his profession. He must be so trained if he hopes to fully exercise his responsibilities as a professional man in contributing to the advancement of the economic and social structure of his community.

SAFETY standards, or safety codes as this particular form of standard is sometimes called, represent one of the oldest forms of accident-prevention work. They were primarily developed in connection with the work of regulatory bodies for the purpose of guiding factory inspectors and indicating to industry ways and means of complying with labor laws pertaining to safety. Insurance groups were also among the pioneers in preparing safety standards and using them as the basis of recommendation to insured companies.

Development of the Boiler Code

The ASME was one of the pioneers in this field of activity through its development of the Boiler Code. This was a particularly important pioneering effort because of its relationship to the work of regulatory bodies. The Pennsylvania Department of Labor and Industry adopted the Code in 1916. Since that time the Code has become the bible in regard to the design and construction of boilers and pressure vessels. The development of the Code was particularly important because it was one of the first if not the first example of co-operative effort in building a standard and of the influence which a great professional organization can be in creating a desire on the part of governmental agencies to join with those who must comply with the law in determining how such compliance should be met. All too frequently regulatory bodies and governmental agencies had been operating as though they had all and sufficient knowledge in themselves. They also had assumed an attitude that seemed to indicate that they had no faith in industry's recommendations. There was some justification for this as industry on many occasions had tried to keep such regulations to the minimum in number and as innocuous in character as possible. ASME, with no ax to grind and knowing that pressure vessels are a constant source of potential danger if not designed, constructed, operated, and maintained according to the best safety practices, and having within its membership people with the best technical knowledge available, functioned to bring together in a national co-operative effort all who were vitally concerned with the subject of pressure safety. The effort has been a tremendous success.

Contributed by the Safety Division and presented at the Annual Meeting, New York, N. Y., Nov. 25-30, 1956, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Paper No. 56—A-188.

Application of Safety Codes

The early importance attached to the regulatory aspect of safety codes has developed an impression that such standards are intended primarily for the use of regulatory bodies. This is unfortunate from several angles. Many, many safety codes contain technical information not only of value to the safety specialist but also to the practicing engineer. Some of the most valuable technical literature exists in the form of safety standards. In fact in some cases the safety standard is the only place where certain technical information can be found. It was for this reason that the American Standards Association in its list of American Standards assembled all of the safety documents in a separate section of the publication under the title "American Safety Standards." The word "code" might appear in the title of the individual standard, but collectively they were presented as safety standards without special regulatory significance and were intended for the use of everybody.

A few years ago, Arthur S. Johnson and Nicholas Prasinos of the American Mutual Liability Insurance Company developed a paper which they presented before the American Society of Safety Engineers during the 41st National Safety Congress, designed to stress the importance of safety standards in accident-prevention work. Many of those who heard the presentation or who read the paper were greatly impressed with the extent of the subjects covered and the number of standards developed. The paper was written in two parts. The first discussed the significance of safety standards. The second consisted of a listing, in 40 pages, of standards on a great variety of subjects and the organizations under whose auspices the standards were developed. This brought home to the safety specialist the fact that standards existed for their everyday use on almost every subject of interest. It also made many conscious of their incomplete knowledge, if they had not become familiar with the contents of those standards that most closely related to their daily problems. ASA knows that this is so because of the increase in sales of the American Standards listed in the paper.

By intent, the paper of Messrs. Johnson and Prasinos was directed to those whose vocation was accident prevention and discussed only those standards developed

primarily as safety standards. No attempt was made to refer to the many, many standards generally considered as engineering standards but which also are significant from a safety point of view. To have done so would have been a colossal task and would have turned the paper into a catalog. Nevertheless, it is important to emphasize that in terms of present-day industrial operations every standard is a safety standard. Some to a higher degree than others, it is true, but safety is there just the same.

A Look at Two American Standards

The ASME along with the Society of Automotive Engineers has been giving leadership to the development of the American Standard for Screw Threads. In fact, ASME has been giving leadership in the field of screw threads since 1916, two years before the American Standards Association was born. But how many engineers — safety, mechanical, or otherwise — have thought of the screw-thread standard as a safety standard? Probably not too many. But what does the standard say? The publication of the standard contains a historical note and part of that note reads as follows:

"The American national screw thread system, developed by the commission and the sectional committee working concurrently but independently, retained the basic U. S. standard thread form for the external thread, but the maximum metal condition provided for a fuller minor diameter and, accordingly, greater wear of cutting tools. The minor diameter of the internal thread was enlarged to provide for a maximum of $83^1/_3$ per cent thread height. Tests had proved that this greatly facilitated tapping without impairing the strength of the assembly. A complete specification was developed for both a coarse and fine-thread series which incorporated the USS, SAE, and ASME diameter-pitch combinations which had been in general use. Four classes of tolerances, or tolerances and allowances for each thread were provided and complete limits of size set up."

This means that one of the primary purposes of the screw-thread standard was to obtain maximum strength of the assembly. Certainly interchangeability and economy of manufacture and maintenance are matters of primary importance in the development of the thread system. But the strength of the assembly was the main thing. Incidentally, this quotation from the standard illustrates very clearly something that safety specialists have been trying to put across to designers and engineers in general from the beginning of the safety movement, namely, that the safe way is the economical way. To put it another way, we might say that one can be economical and safe at the same time.

Let's take a look at another mechanical standard, the American Standard for Steel Socket-Welding Fittings, B16.11-1946, as reaffirmed in 1952. We find two things: First, reference is made to material specifications developed by the American Society for Testing Materials. These specifications were not drawn to call for a material that will be easy to cut or shape. They were drawn so as to insure appropriate strength for the service to be rendered. Second, we find reference to metal thickness and the bursting strength of the fittings. After stating that, as these fittings are to be used in connection with pipe, the wall thickness must be equal to or greater than the nominal wall thickness of pipe as established by American Standard B36.10 with which they are used, the standard goes on to discuss adequacy of fitting design as follows:

"To insure adequacy of fitting design, the actual bursting strength of fitting shall be not less than the computed bursting strength of the pipe of the designated schedule member and material."

This requirement then goes on to tell how we should determine the relative strength of the fitting by means of a hydrostatic test conducted until either the fitting or pipe bursts. Why all this talk about wall thicknesses and bursting strength? Because those who drafted the standard were interested to see that safety was built into socket-welding fittings, and for no other reason. Incidentally, this standard refers to two other standards, namely, those of ASTM and American Standard B36.10. So the evidence begins to mount.

Analysis of standards considered as engineering standards in terms of their contribution to safety could go on and on. They are not safety standards or safety codes in the usual sense of those terms, but standards of safety nevertheless. Therefore it is clear that one must not limit himself to the usual safety code when seeking information on safety in design, construction, operation, maintenance or what have you. All standards that have any bearing whatsoever should be critically examined for clues.

Purposes of ASME Safety Committee

The ASME Committee on Safety (now the Safety Division) is of long standing. Year after year the Committee has developed safety programs for sessions of the Annual Meetings of the Society as well as for other forums. Certainly the Society is interested in the broad sense of making a contribution to the advancement of the economic and social welfare of the nation. But is this sufficient reason for the special emphasis on safety as evidenced by a special committee and special programs, you may ask? It would seem that the answer must rest in the objective of a professional society to advance the profession in every possible way and to serve the membership also in every possible way. The Safety Committee, which supervises the development of safety standards or codes under ASME leadership and is responsible for service to members in accident prevention, is interested in broadly serving the membership of the Society and not just the few members who happen to have chosen the field of accident prevention in which to work. An attempt has been made in this discussion to emphasize this objective.

One of the slogans used in accident prevention is "safety is everybody's business." Every engineer is concerned with safety. He cannot reach the full heights of his profession unless he practices accident prevention at all times. Likewise the engineer who may be a safety specialist will not reach his full potential as a specialist if he limits his knowledge to that which is written specifically for him. He must be fully conversant with all engineering practices to be fully informed, in tune with the times, and at the top of his profession.

We have tried to indicate how standardization has made a basic contribution to accident prevention. Safety codes, as important as they are, do not represent this contribution in full. If safety is everybody's business, then all standards of safety are everybody's business. Let's put them to work!

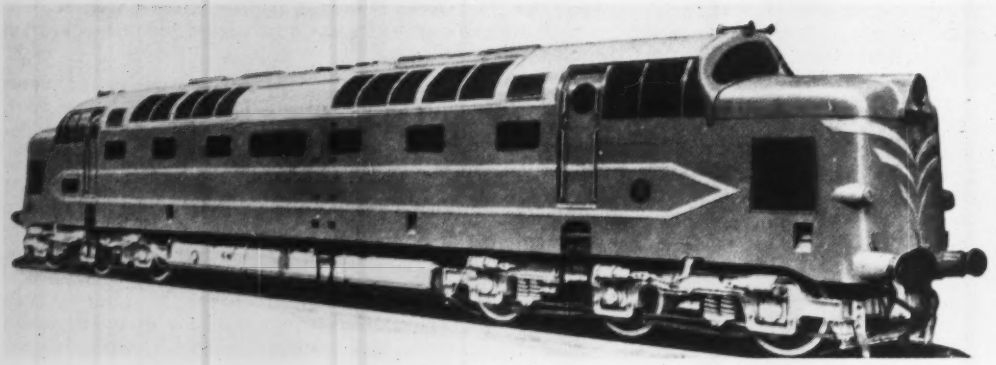


Fig. 1 3300-hp British-built diesel-electric locomotive equipped with two 1650-hp Napier Deltic engines

Progress in Railway Mechanical Engineering —1955-1956

THE MOTIVE-POWER picture throughout a great part of the world continues to be dominated by the diesel prime mover. In the United States the distribution of motive-power types as of August 1, 1956, is shown in Table 1.

Table 1 Locomotives of Class 1 Railroads of U. S. (1)[1]

	Diesel	Steam	Electric	Gas turbine	Steam turbine	Total
Units owned or leased	25713	4489	607	25	1	30835
Units stored serviceable	219	678	8	0	0	905
Units awaiting repair	920	740	80	0	0	1740

The high degree of standardization attained by locomotive builders in America appears to be influencing both the foreign railroads and the foreign builders of locomotives and locomotive components. Additional domestic builders are exporting standardized types of locomotive units, while numerous foreign builders are manufacturing locomotives in a more repetitive manner.

Several new types of electric locomotives have been installed in the United States and abroad during the year particularly in Europe.

Report of Committee RR-6 Survey: Chairman, D. R. Meier; members, F. A. Benger, R. M. Coultas, H. G. McClean, and F. L. Murphy.

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Railroad Division and presented at the Annual Meeting, New York, N. Y., November 25-30, 1956, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Paper No. 56—A-194.

NOTE: The survey covers the period September 1, 1955, to September 1, 1956.

While there are no steam locomotives being reported, there has been continued production of previously reported types built in substantial quantities. Great Britain, for example, has continued to export large numbers of steam locomotives.

The General Electric Company announced the receipt of an order for fifteen 8500-hp gas turbine-electric locomotives for the Union Pacific Railroad. These locomotives, each consisting of two cabs having C-C truck arrangements, will be used for freight service.

A gas-generator locomotive built by Götaverken A.B. has been in operation on the Swedish State Railways (2). The gas generation is accomplished in a 5-cylinder opposed-piston-type engine having one crankshaft with three cranks for each cylinder. The scavenging-air-compressor piston is attached to the upper power piston and works in its own cylinder. A valve is provided for directing the gas output to the turbine or directly to the exhaust. The turbine is a 7-stage machine and is connected to the axle through reduction gears and a hydraulically operated friction clutch. The locomotive wheel arrangement is 1-C-1. Rated power is 1000 hp at the rail.

While the use of nuclear power continues to attract attention, no outstanding developments in concepts of applying this power to locomotives were reported in 1956.

Diesel Locomotives

A 3300-hp diesel-electric locomotive having the remarkably low weight of 72 lb per hp is shown in Fig. 1

and listed as item 1 of Table 2. It is equipped with two 1650-hp opposed-piston two-cycle Napier Deltic engines shown in Fig. 2.

Alco Products, Inc., has brought out two new locomotives using its recently developed 251 series engines. The larger is a 2400-hp 6-motor road-switcher unit illustrated in Fig. 3 and described as item 2 of Table 2. The smaller is an 1800-hp locomotive also of road-switcher design shown in Fig. 4 and listed as item 3 of Table 2. This unit is available in both 4-motor and 6-motor forms.

The General Electric Company has announced a new line of diesel-electric locomotives, specially designed to meet the requirements of railways abroad. The line comprises nine different sizes ranging from 400 to 1980 hp. The first of this line to be built is the 1980-hp size which is shown in Fig. 5 and is described as item 4 of Table 2.

The South Australian Railways has put into service the first of a lot of 1750-hp diesel-electric locomotives manufactured in Australia to designs furnished by Alco Products, Inc. The six-motor streamlined cab unit is shown in Fig. 6 and its main features are listed in item 5 of Table 2.

The General Motors Corporation is marketing a stand-

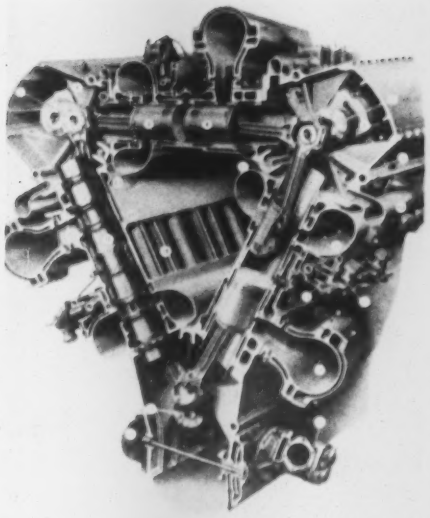


Fig. 2 Sectional view of Napier Deltic engine

Fig. 3 Alco 2400-hp six-motor locomotive designed for road-switching service

Table 2 Diesel Locomotives

Item No.	1	2	3	4	5	6	7	8
Builder—mechanical	Eng. Elec.	Alco	Alco	GE	Goodwin	GM	GE	BLH
Builder—electrical	Eng. Elec.	GE	GE	GE	GE	GM	GE	
Owner	British	Various	Various	Mexico	Australia	Various	Manila	NYC
Service	F&P	F, P, Sw	F, P, Sw	F, P, Sw	F&P	F&P	F, P, Sw	P
Wheel arrangement	C-C	C-C	B-B	B-B	C-C	B-B	C-C	B-2
Engine data:								
Engines per cab	2	1	1	1	1	1	1	1
Hp ratings per engine	1650	2400[a]	1800[a]	1980	1750	1425	1200	1000[a]
No. of cylinders	18	16	12	12	12	12	8	12
Bore and stroke, in.	$5^1/_8 \times 7^1/_4$	$9 \times 10^1/_2$	$9 \times 10^1/_2$	$9 \times 10^1/_2$	$9 \times 10^1/_2$	$8^1/_2 \times 10$	$9 \times 10^1/_2$	7.5×7.9
Engine speed, rpm	1500	1000	1000	1000	1000	855	1000	1500
Cycles	2	4	4	4	4	2	4	4
Supercharging	No	Yes	Yes	Yes	Yes	No	Yes	Yes
Manufacturer	Napier	Alco	Alco	CB	Alco	GM	CB	Maybach
Weight on drivers, lb	237500	335000	240000	240000	228480	175000	182000	117950
Total locomotive weight, lb	237500	335000	240000	240000	228480	175000	182000	198000
Fuel capacity, gal	800	1350	1200	900	1600	1000	500	700
Driving-wheel diameter, in.		40	40	40	40	40	38	36
Type of transmission	Elec.	Elec.	Elec.	Elec.	Elec.	Elec.	Elec.	HM
Track gage, in.	$56^1/_2$	$56^1/_2$	$56^1/_2$	$56^1/_2$	63	$56^1/_2$	42	$56^1/_2$
Maximum speed, mph	90	80	92	65	70	65	60	120
Fig. no.	1	3	4	5	6	7	8	20

[a] Indicates horsepower is net horsepower for traction use.

Alco—Alco Products, Inc.
BLH—Baldwin-Lima-Hamilton Corp.
GE—General Electric Co.
GM—Electromotive Division, General Motors Corp.
CB—Cooper-Bessemer Corp.
Napier—D. Napier & Son, Ltd.
Mexico—National Railways of Mexico
Australia—South Australian Railways
Goodwin—A. E. Goodwin, Ltd.
HM—Hydro-Mechanical
NYC—New York Central R.R.
F—Freight
P—Passenger
Sw—Switching

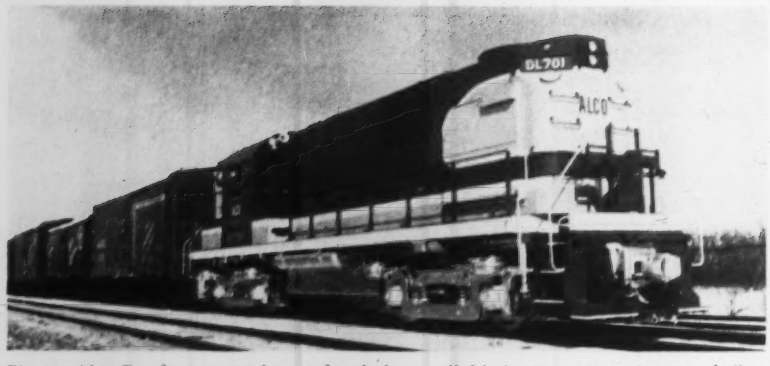


Fig. 4 Alco Products 1800-hp road switcher available in 4-motor or 6-motor design

Fig. 5 General Electric locomotives for Mexico—one of nine sizes ranging from 400 to 1980 hp for foreign railroads

ard line of locomotives designed for export service and featuring the 567-C engine in the 6, 8, and 12-cylinder models. Representative of this line are the 70 diesel-electric locomotives for the Iranian State Railways, one of which is shown in Fig. 7. These are 1425-hp four-motor units, with road-switcher cabs whose principal features are listed in item 6 of Table 2. They are equipped with trucks of the "flexicoil" design in which the bolster is supported on coil springs and is restrained in vertical and lateral movement by friction snubber pistons. Similar locomotives were furnished by the same builder to the New Zealand Government Railways. These latter units were provided with three-axle trucks in which the middle axle is unmotored.

The Manila Railroad in the Philippine Islands has put into service thirty 1200-hp diesel-electric locomotives. A novel feature of the design of 20 of these locomotives, one of which is shown in Fig. 8, is the combining of the attractive appearance of the streamlined cab and the easy accessibility of the road switcher. The details of these units are shown as item 7 of Table 2.

The locomotive for Train "X" (shown in Fig. 20) was built by Baldwin-Lima-Hamilton Corporation. It features a hydraulic-mechanical transmission consisting of a hydraulic torque converter and a four-speed gearbox with gears in constant mesh. Gear-ratio changes are effected by automatically controlled jaw clutches. In addition to the 1000-hp propulsion engine, there is a 570-hp auxiliary engine which furnishes power for the train and for locomotive auxiliaries. Since the locomotive was especially designed to haul a lightweight train, its two front axles only are driven. The cab has a special low contour to match the cars of the train. Further details are shown as item 8 of Table 2.

Electric Locomotives

The German State Railways has received and put into service the first of a series of four new standard types of electric locomotives for its 15-kv $16^2/_3$-cycle single-phase system. After extensive trials, the idea of building general-purpose locomotives has been abandoned and four specific-purpose types have been selected as standard after years of development and tests. One of these, the E41 type, intended for express and interurban traffic with light trains is shown in Fig. 9 and listed as item 1 of Table 3.

Forty 3475-hp 1500-volt d-c locomotives have been built for the New South Wales Railways in Australia by Metropolitan-Vickers. These locomotives, described in item 2, Table 3, and illustrated in Fig. 10, are the largest electric locomotives ever exported from Great Britain.

The development of the rectifier-type electric locomotive has continued during the year, and Fig. 11 shows one of 12 rectifier locomotives built for the Virginian Railway by the General Electric Company. Details of these locomotives which are built for multiple-unit operation are given in item 3, Table 3. These locomotives will be used in heavy freight service.

Fig. 6 Goodwin-built 1750-hp diesel-electric locomotive

Eighty-three d-c locomotives have been built in Belgium for the Belgian National Railway (Fig. 12). Designed for both freight and passenger service, these locomotives are operated at speeds up to 80 mph and are described in item 4, Table 3. A patented feature of

these locomotives is the use of a prefabricated frame in which all cables are assembled, following which the frame is welded to the chassis (Fig. 13). This method permits separate assembly of wires and cables prior to locomotive assembly and is said to result in lower manufacturing cost.

The same manufacturing techniques as described in the foregoing have been employed in the building of ten 2200-hp d-c locomotives for the Belgian Congo. One of these units is shown in Fig. 14. Data are provided in item 5, Table 3.

Fig. 7 General Motors locomotive—one of a standard line designed for export

Lightweight Trains and Railcars

Last year's report dwelt on the development work then in progress on new concepts of lightweight low-center-of-gravity passenger trains and described two trains where experimental pilot models had been tested (3)—the ACF "Talgo" and the General Motors "Aerotrain." Mentioned were the Train X development by Pullman-Standard, the Budd tubular train for the Pennsylvania as well as the Budd modified RDC for high-speed operation on the New Haven (4). The development of the various lightweight low-center-of-gravity passenger-train cars was undertaken with the anticipation that use of these cars would result in a considerable reduction in operating costs of passenger-car trains.

Since last year's report, the ACF Talgo train, identified as the "Jet Rocket," has been delivered to the Rock Island Railroad and is now operating in revenue service. Two General Motors Aerotrains have been completed and they are in experimental service on the Pennsylvania and the New York Central Railroads. The Pennsylvania tubular train built by Budd and the Train X developed by Pullman-Standard for the New York Central are now in operation. The Budd Company has introduced a new concept of its own design known as the "Pioneer III," described later.

Detailed descriptions of the ACF Talgo train, the General Motors Aerotrain, the Budd tubular train, and the Pullman-Standard Train X were given in papers presented at the last year's meeting (5, 6, 7). Detailed descriptions of these trains as well as the Budd Pioneer III also are given in railway trade publications and, therefore, only a brief outline of a few salient features of each train is included in this report and comparisons are given in Tables 4 and 5.

ACF Talgo or Jet Rocket Train. The original Talgo train was a fixed consist of completely articulated cars designed for single-direction operation. The train as now built and in service on the Rock Island Railroad and known as the Jet Rocket, is made up of individual cars—each car comprised of three units. The units are semi-permanently connected together to form a car somewhat longer than a standard passenger car. This three-unit car may be coupled or uncoupled readily and is reversible. The basic design of the car is a coach, but through use of standardization dimensions that were developed in the design, it is possible to adapt this car to parlor, diner, or sleeping-car combinations.

Fig. 8 1200-hp diesel-electric locomotive for Manila Railroad

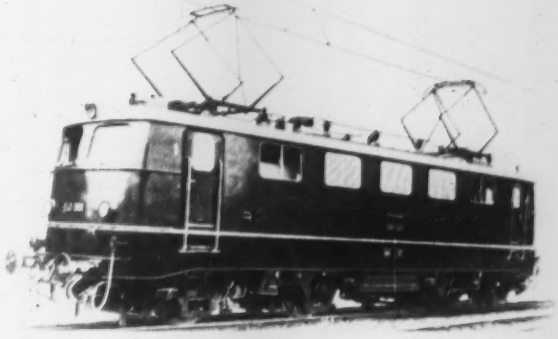


Fig. 9 Standard-type locomotive for express and interurban service in Germany

Budd Pioneer III. Budd has built a new design of ultra-lightweight passenger car identified as Budd Pioneer III. This car is described in Table 4 and is illustrated in Fig. 15 (8).

Fig. 10 British-built 3800-hp locomotive for Australia

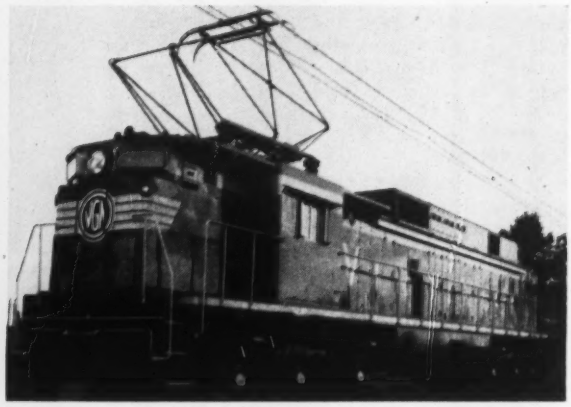


Fig. 11 Rectifier locomotive built for the Virginian Railway

Perhaps the most unusual feature of this car is the completely new design for trucks which weigh 6320 lb each (Fig. 16). The principal parts of this truck are the pressed-steel side frames, a welded truck bolster, and two air springs. The air springs work in conjunction with the bolster which serves as a reservoir and softens the

Table 3 Electric Locomotives

Item No.	1	2	3	4	5
Railroad	Germany	Australia	Virginian	SNCB	BCK
Builder—mechanical	Henschel	Metro-Vick	GE	B&N	B&N
Builder—electrical	BBC	Metro-Vick	GE	ACEC, SEM	ACEC
Wheel arrangement	B-B	C-C	C-C	B-B	B-B
Service	F&P	F&P	F	F&P	F&P
Power supply	15 kv $16^{2}/_{3}$ cps	1500 V d-c	11 kv 25 cps	3000 V d-c	25 kv 50 cps
Power conversion	A-C series motor	—	Ignitron rec.	—	A-C series motor
Current collector	Panto	Panto	Panto	Panto	Panto
Driving wheels:					
Number	8	12	12	8	8
Diameter, in.	$49^{1}/_{4}$	45	40	$49^{11}/_{16}$	$51^{3}/_{16}$
Weight, lb:					
Total	141000	242000	396000	205000	168000
On drivers	141000	242000	396000	205000	168000
Per driving axle	35250	40330	66000	51250	42000
Dimensions, ft-in.:					
Length over-all	51-7	54-0	69-6	$59\text{-}0^{1}/_{4}$	51-0
Width over-all	9-10	9-7	$10\text{-}3^{1}/_{8}$	$9\text{-}11^{1}/_{4}$	$9\text{-}10^{1}/_{4}$
Height, panto down	—	14-6	15-10	—	—
Rigid wheel base	10-6	14-0	13-0	$11\text{-}10^{1}/_{2}$	$11\text{-}10^{1}/_{2}$
Total wheel base	34-5	41-0	$53\text{-}9^{3}/_{4}$	$40\text{-}0^{7}/_{8}$	$34\text{-}0^{9}/_{16}$
Traction motors:					
Number	4	6	6	4	4
Method of mounting	Truck-mounted	Axle-hung	Axle-hung	Axle-hung	Axle-hung
Method of drive	Quill	Gear	Gear	Gear	Gear
Gear ratio	—	19/67	18/74	1/3.107	1/4.63
Tractive force, lb:					
One-hour rating	—	42000	79500	44100	37500
Per cent adhesion	—	17.4	20	21.5	22.4
Continuous rating	20250	37200	79500	40600	—
Per cent adhesion	14.4	15.4	20	19.8	—
Rail horsepower:					
One-hour rating	—	3820	3340	2560	2200
Continuous rating	2815	3475	3340	2360	—
Speed, mph:					
One-hour rating	—	34	$15^{3}/_{4}$	—	—
Continuous rating	52	35	$15^{3}/_{4}$	—	—
Maximum	75	70	65	78	43
Regeneration	—	Yes	No	Yes	No
Multiple-unit operation	Yes	Yes	Yes	No	Yes
Track gage, in.	$56^{1}/_{2}$	$56^{1}/_{2}$	$56^{1}/_{2}$	$56^{1}/_{2}$	42
Fig. no.	9	10	11	12, 13	14

Germany—German State Railways
BBC—Brown, Boveri & Co., Switzerland
Australia—New South Wales Railways
SNCB—Belgian National Railways
B&N—Brugeoise & Nivelles, Belgium
ACEC—Ateliers de Construction Electriques de Charleroi, Belgium
SEM—Société d'Electriques et de Mécanique à Gand
BCK—Bas-Congo to Katanga Railway, Belgian Congo
GE—General Electric Company
F—Freight, P—Passenger

rate of the air spring. By means of a unique damping orifice that is built in between the springs and the reservoir, the single spring has a variable spring rate and serves the purpose of the conventional double-spring system on standard trucks. The truck frames are formed of two stampings welded together and are allowed to articulate around a central pivot bearing attached to the bolster beams. The side frames carry the roller journals mounted inboard of the wheels permitting a lighter axle and an accessible installation of disk brakes outside the wheel. The air springs are adjacent to the side walls of the car body, hence the bolster is not subjected to heavy bending stresses and therefore can be light in weight. The truck bolster bearing directly against the truck frames also is light in weight.

The air brakes used in this car are electropneumatic straight air system with Budd-design variable-load attachment in combination with Budd disk brakes.

While all the new passenger cars make extensive use of plastics, this car uses molded plastics to a greater degree both on the exterior and interior. Single pieces of molded-plastic units are used through the exterior and the interior finish of the Pioneer III. The step wells are made of laminated fiberglas-reinforced plastic. This plastic also is molded to the desired interior shapes allowing one-piece design and eliminating supporting structure. The desired color is built into the units so that no painting is required. Each bay or window frame in the coach section is single-panel and extends from the heater guard to the luggage rack and includes the window trim and the lower baggage-rack surface. A second panel combines the upper surface of the baggage rack and ceiling and one half of the air duct. The seats are fixed semibucket type also of molded plastic mounted on an aluminum base and utilizing a removable vinyl-foam-cushion upholstery pad.

General Motors Aerotrain. The General Motors Aerotrain was evolved from a standard General Motors Company 40-passenger intercity coach body which was increased in width 18 in. and to which a vestibule was added at one end. Each car is an independent unit for flexibility. The seat level is made as high as possible for visibility, yet over-all height as well as center of gravity is kept low. Two wheels are used at each end of the car supported by a General Motors "air ride" suspension adapted to a railroad car. At each end of the axle two air bellows support the weight of the body. The bellows are attached to air boxes which are built into the underframe and both are charged with air at 55 psi maximum from a reservoir in turn charged from the train line utilizing a 75-psi limit valve preventing the drawing of air from the air brake until the system is fully charged. The air pressure in the bellows is controlled between upper and lower limits holding the height of the car body constant (Fig. 17).

The air brakes are of a special design developed by General Motors for use in a train of cars and locomotives which will operate as a unit (9).

Pennsylvania Tubular Train. Budd built for the Pennsylvania Railroad an eight-car, lightweight, stainless-steel train identified as a "tubular" design train (10). These cars were built to the railroad's specifications and use four-wheel trucks. The cars have the usual end platform height, arrangements, and couplers. The center portion of the car is depressed so that the floor is just 24 in. above the rail. The cars can be coupled with conventional equipment and can stop at existing platform stations. There are seven coaches on the train plus a head-end auxiliary power car (Fig. 18). There are seats for 56 passengers on the lower level and 26 more on the higher level.

Fig. 12 2560-hp locomotive for Belgian National Railways

Fig. 13 Prefabricated frame of locomotive shown in Fig. 12

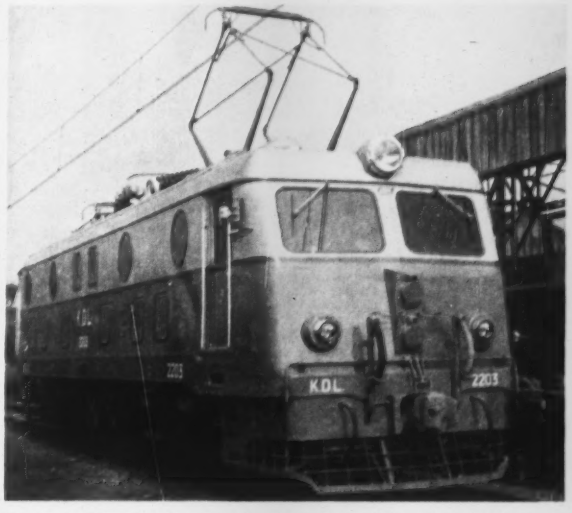


Fig. 14 2200-hp locomotive built in Belgium for the Congo

Table 4 Dimensions of Lightweight Trains

	ACF Talgo	Budd Pioneer III	General Motors Aerotrain	Penna.-Budd Tubular	Pullman-Standard Train X
Type	3-unit articulated	Single cars	Single cars	Single cars	9-unit articulated
Length—total, ft-in.	109-5½	—	—	—	445
Length—units, ft-in.	34-6½ over end sills	85-2	40-0	85-0	1—48-0 center unit 4—48-0 int units 4—51-3 vest units
Height—rail to roof ft-in.	10-10¼	11-6	10-9	11-11	11-0
Width, ft-in.	10-2	10-0	9-6	10-0	10-0
Height—platform, in.	26	43½	43	51	23
Height—floor, in.	26	39	43	24	23⅜
Height—cg, in.	42	—	45	45	44
Height—coupler, in.	19	34½	34½	34½	13½
Seat centers, in.	36	34	35	35½	39
Wheel diameter, in.	28	30	33	34	28
Number of axles	4	4	2	4	10
Number of seats	96	88	40	82	392
Total weight, lb	70000	52330	38000	82000	274000 Total
Weight per seat, lb	729	595	980	1000	699

Table 5 Comparison of Features of Lightweight Trains

	ACF Talgo	Budd Pioneer III	General Motors Aerotrain	Penna.-Budd Tubular	Pullman-Standard Train X
Power (head-end)	440-volt 3-phase AC separate aux. power car (40 kw per 3-unit car)	Not on car. Utilizes 440-volt 3-phase AC	440-volt 3-phase AC	440-volt 3-phase AC, 530 kw (Separate head-end power car)	440-volt 3-phase AC, 284 kw; automatic trainline
Heating	Two-step electric overhead; floor heat—hot water from oil-fired heater located in center unit	Steam from head end to side wall and overhead	Hot-water system electric-immersion heaters plus oil-fired hot-water heater in each car	Electric floor and overhead	Electric overhead and side-wall panel heaters
Air conditioning	Two 5-ton units for 3-unit car; one unit for light demand; two units for heavy demand	Electric—mech	5-ton unit per car; runs continuously; control by means of by-pass	8-ton unit; modulation by cylinder unloading	One 6-ton per unit; modulation by cylinder unloading
Motive power	1-GM Aerotrain type locomotive	Conventional locomotives	1-GM Aerotrain type locomotive	Conventional locomotives	B-L-H locomotive (Table 2)
Materials—underframe	LAHT Steel-welded	Welded alloy draft sill	Steel	LAHT end unit welded	Steel end units
Materials—body	Aluminum-riveted SS skin-riveted	Stainless steel, shot-welded	Steel	Stainless steel, shot-welded	Aluminum-riveted
Strength	Applicable AAR. 800-000 lb buff. load; associated requirements for sides, ends, and roof	Full AAR	600000 lb end load	AAR and RMS	800,000 lb buff. applicable AAR and RMS specifications
Couplers	Auto. including electric and brake, Ohio Brass Co.	AAR Type "H"	Auto. incl. electric and brake	AAR Type "H"	Auto. including electric and brake; electric trainline overhead. Westinghouse Air Brakes
Trucks and suspension	One pair independent wheels per end units, 2 pairs on center unit; spring suspension; hydraulic shock absorbers	2 4-wheel welded trucks air spring suspension	Two axles per car; air spring suspension	2 4-wheel cast-steel trucks; spring suspension	Steered single axle per unit; two axles center unit; air spring suspension; hydraulic shock absorbers
Brakes—Air	Conventional #26-C auto. with #26 control valve	N.Y.A.B. L.W.E. Elect. pneumatic straight air plus Budd variable-load attachment	Gen. Motors design straight air system	H.S.C. with D-22-AR. control valve pneumatic only	N. Y. Air Brake Co. L.W.E.
Brakes	Single-shoe cobra type on wheel	Disk mounted outside of wheel	Nonmetallic on wheel trend	Disk	Cobra shoe on wheel tread

This train has a separate auxiliary power car 53 ft long which contains two 12-cylinder 400-hp diesel generator sets. These supply power to the seven cars for heating, air conditioning, lighting, and auxiliary uses. An 18½-ft section in this car is devoted to food service. Supplemental batteries are installed in each car for emergency lights and for heating and cooling controls (Fig. 19).

The trucks are four-wheel, single-equalizer, outside swing-hanger type with 5 × 9 roller bearings.

Pullman-Standard's Train "X." Fig. 20 shows a view of Train X—a 9-unit articulated train designed for two-directional operation so that a power unit may be used on either end (11). The center unit has two pairs of wheels, one pair at each end and the remaining eight units, four of which are connected to either end of the center unit,

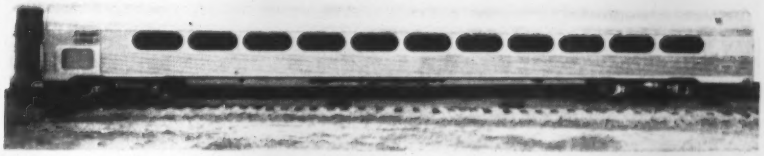


Fig. 15 New design of ultra-lightweight passenger train, Pioneer III, built by Budd

have one pair of wheels at their outer ends. These eight units are made up into four two-unit sections. The two-unit sections are permanently coupled and articulated. At the coupling end of these sections an automatically operated pair of dolly wheels, interlocked with the coupling mechanism, raise and lower in coupling to allow for the switching and cutting of the units in and out of the train by pairs.

The truck utilizes a self-leveling air-spring suspension in combination with the low center of gravity of the body and a high point of suspension of the car body on air springs to attain unique riding characteristics.

The brakes are actuated pneumatically, but controlled by electric pneumatic brake equipment. Brake pressure is varied automatically by the weight of each car so that the maximum possible braking within the limits of rail adhesion is attained.

Speed Merchant. Fairbanks-Morse has under construction new locomotives which will power lightweight trains on the New Haven and the Boston & Maine Railroads.

Germanium Rectifier Rail Cars. The initial installation of a germanium power rectifier to a railway vehicle was made on the Lancaster-Morecambe-Heysham line of the British Railways which is electrified with 50-cycle single-phase a-c power at 6600 volts. The rectifier, supplied by British Thomson Houston Company, is rated at 750 kw and was installed in an existing motor car in place of the mercury-arc rectifier with which the car was provided originally.

Italian Rail Cars. The Italian Fiat Company is building for the Indian State Railway 12 meter-gage diesel railcars for interurban operation. Each car will have a Fiat 700A 6-cylinder 4-stroke "pancake" diesel engine with a rated output of 210 hp at 1550 rpm. Six cars will have a hydromechanical transmission consisting of a fluid coupling of the twin rotary type and two-plate dry-friction clutch and a five-speed gearbox with a final drive going to both axles of one of the trucks. The hydraulic transmission on six cars features a hydraulic torque converter mounted directly on the engine which cuts out at two thirds of maximum speed when the rail car runs on direct drive. Power transmission from the converter is to both axles on one truck. The cars are 63 ft $10^3/_4$ in. long, weigh 29.4 metric tons, have a maximum speed of 50 mph, and seat a total of 73 people.

Absolute Guidance Train. A long-accepted basic foundation for train operation, that is, a flanged wheel on steel rail, is eliminated in a radical new train design being proposed in Argentina (12). The new train, designed for extremely high speeds, would be operated on rails built approximately 3 ft above the ground. A new system called "absolute guidance" would replace the wheel flange. Pneumatic tires would ride directly on top of a broad-flange rail and the absolute guidance would be attained by small wheels contacting a sloping underside of the rail on which the supporting wheels ride. It is claimed that, with this design, weight plays no role in stabilizing the cars and that the cars can be extremely light—200 lb per seat, with the center of gravity below the center of the wheels.

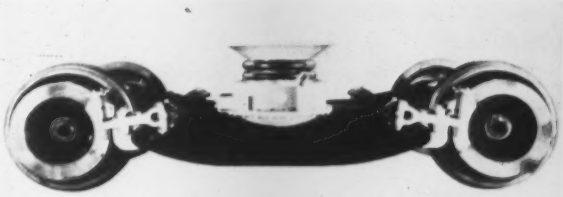


Fig. 16 Unusual truck designed for the Pioneer III car

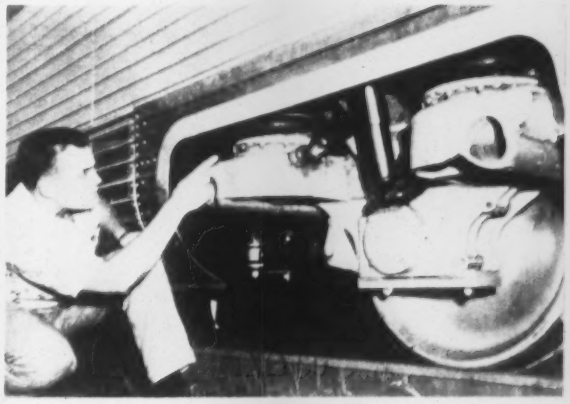


Fig. 17 Air bellows; suspension system on G-M Aerotrain

Passenger Cars

Santa Fe High-Level Coaches. Two years ago, this report described the two high-level chair cars built by Budd and placed in experimental service on the Santa Fe (13). This year, Budd completed 47 high-level cars for service in the Santa Fe chair-car trains, the *El Capitan*. These cars consisted of 35 chair cars, six diners, and six dome or lounge cars. Each of the coaches seats 72 people on the upper level 8 ft above the rail (Fig. 21). The lower level contains the vestibule, luggage space, toilet and wash rooms. The upper levels of the dining car are devoted to

Fig 18 View of the Pennsylvania eight-car tubular train

Fig. 19 Power car with two 400-hp diesel-generator sets

Fig. 20 Nine-unit articulated train "X" designed by Pullman-Standard for two-directional operation so that a power unit may be used on either end

table space for 80 diners with the kitchen located on the lower level from which food is transported by means of two elevators. The full-length dome-type lounge cars seat 88 people on the upper and lower levels. These also have a newsstand, a refreshment bar, and rest rooms.

Seaboard Cars. Pullman-Standard built for the Seaboard Air Line three combination sleeper-bar-lounge cars and seven new coach-lounge cars which included certain innovations in passenger cars. A unique feature is the large curved glass panels in the roof extending from the side plate to the center air duct giving the passengers overhead vision, through tinted heat-resistant glass to supplement the large side windows.

French Sleeping Cars. The first of 50 new International Sleeping Car Company's single-berth stainless-steel sleeping cars have been delivered and placed in service in France. The cars have 20 single-berth, second-class compartments accessible from a side corridor, are of the duplex bedroom type, that is, the upper and lower rooms are staggered. The trucks feature a suspension system basically similar to that used on automobiles; each truck has helical springs and hydraulic shock absorbers.

Lightweight Japanese Cars. Fig. 22 shows the first passenger car built in Japan which is of real lightweight construction. The car, which is 65 ft 7 in. long, weighs 53,300 lb—a weight reduction of 29 per cent in contrast to the previous standard-type cars. A lightweight sleeping car has also been placed in service.

Freight Cars

Developments in the freight-car field during the past year continue to emphasize the special-purpose type of cars.

Fig. 21 High-level dining car for the ATSF, seating 80 diners

flatcars rebuilt in its own shops. Each car contains four transverse bulkheads, and two end bulkheads form compartments for the shipping of 30 aluminum ingots each weighing 5000 lb between the aluminum reduction mill and the rolling mill. The bulkhead design speeds both loading and unloading by means of a lift truck and eliminates the need for blocking and dunnage (Fig. 25).

The Missouri-Kansas-Texas has built some special flatcars equipped with strong extra-deep steel bulkheads designed to restrict heavy loads from shifting and to facilitate loading and unloading. This car is a variation of the cars used for many years to handle plywood and in recent years to carry gypsum board.

The Nickel Plate has introduced a basket car for handling thousands of small forgings used in the automobile industry. The car is a standard 50-ft flatcar equipped to carry 24 wire containers each loaded with forgings. The use of baskets permits handling of the forgings direct from the forge to the flatcar and from the flatcar to the point of ultimate usage. All handling operations are made with lift trucks from ground level. The basket car is a simple flatcar with one center longitudinal bulkhead, two end bulkheads and three intermediate transverse bulkheads forming eight compartments each of which holds three baskets. Each basket

ACF Industries introduced a new type of "all-in-one" freight car called the Adapto. It is designed to handle either complete highway trailers or portable containers. Through the use of containers, the car can be converted quickly to a box, gondola, refrigerator, or tank car (Fig. 23). The car is a 38-ft, 4-wheel, multipurpose flatcar. It has two fixed axles on 27-ft centers, connected to the car by four swing hangers per truck. AAR $3^{11}/_{16}$-in. travel coil springs, hydraulic shock absorbers, and 6 × 11 AAR roller bearings are used. The car has a self-cleaning floor, standard couplers, and AAR twin-cushion rubber draft gear. Its light weight is 27,100 lb and it has a load capacity of 77,900 lb.

The International Steel Company has built a new type of compartmentized freight car called the "unit load car" for fast mechanical handling of palletized and "unitized" lading (Fig. 24). The car is 48 ft $5^{3}/_{4}$ in. coupled, is divided into five compartments with access to each compartment through five overhead clearing doors on each side of the car, each opening 7 ft 6 in. wide × 9 ft 3 in. high. Extended neoprene sections seal the doors in the closed position against the elements and stabilize them against vibration and racking. The built-in bulkheads separating the compartments are constructed of a steel framework to which sandwich panels are secured adhesively giving a flush interior.

The Great Northern has installed some bulkhead-type

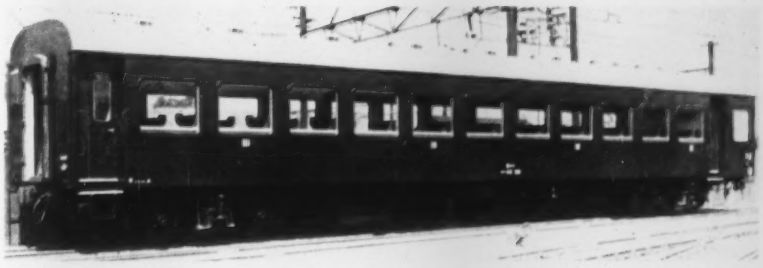


Fig. 22 First lightweight passenger coach built in Japan weighs only 53,300 lb

Fig. 23 ACF Industries Adapto car which handles trailers or portable containers

weighs 200 lb light and 5000 lb loaded. A heavy canvas tarpaulin provides further protection (Fig. 26).

The Seaboard Air Line rebuilt one box car equipped with doorways 20 ft wide on each side of the car (Fig. 27). Each side door is made up of two 10-ft interlocking steel doors. The center door rolls back on its own track alongside of the fixed section of the car side. The end

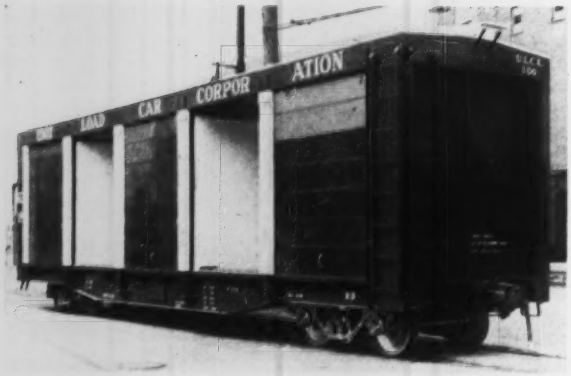


Fig. 24 Unit load car for fast mechanical handling of palletized and unitized lading

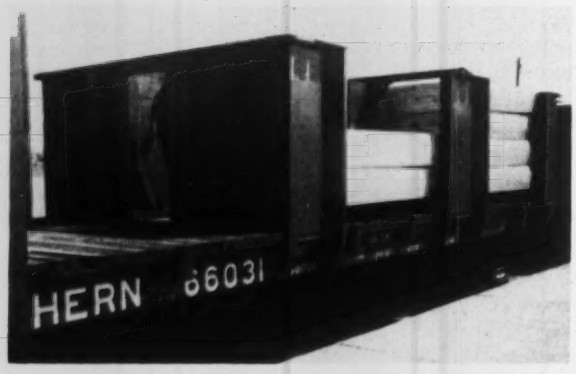


Fig. 25 Bulkhead-type flatcar for shipping aluminum ingots

Fig. 26 Nickel Plate basket car for handling small forgings

10-ft door then is rolled back on a separate track parallel to the center-door section. The doors are located diagonally on opposite sides of the car permitting simultaneous opening of one half of each side of the car. This free access to the interior of the car greatly expedites loading and unloading, adapts it to fork-lift loading, reducing costs to both shipper and consignee. These cars are designed primarily for carrying finished lumber in strapped packages which may be loaded or unloaded rapidly with a fork-lift truck.

The most novel unit exhibited in the past year is the Railvan designed and built by the Chesapeake and Ohio Railway Company (Fig. 28). This unit is designed to run on either rails or highway and is provided with means for transferring from one to the other. The tire carries part of the load when the Railvan is running on rails. Brakes are provided for railroad operation, and there is also provided a special-type coupler and a buffing element. The body is similar to an outside-stake, aluminum-superstructure, highway trailer with a low-alloy, high-strength steel underframe. Both the highway rubber-tired wheels and the rail wheels are attached to a rubber "torsilastic" spring which in turn is connected to the body by metal arms or struts. The highway arm is hinged on the spring and an air motor can twist the spring and transfer the van from the highway to the rail position or back in 30 sec. The air motor has a built-in locking device to lock the suspension system in any position. The coupler used between vans is a male-and-female-type automatic coupler including trainline and is capable of supporting the vertical load as well as taking the draft forces. A specially designed railroad brake is of the spring type where the build-up of air pressure in the trainline releases the brake by compressing the spring. There is a brake cylinder for each rail wheel which is a part of the brake beam which in turn carries the composition brake shoe and the slack adjusters. A standard highway trailer control valve and brake components are used on the highway wheels.

New developments in flat cars for "piggy-back" service, which have been described in reports of the past 3 years, in the past year have been more or less well limited to refinements and improvements. There is some development which may lead to use of container or demountable truck bodies carried on flatcars. The Missouri-Pacific introduced a new version of container for piggy-back service in which the concept is simply to lift the trailer body or container from its underframe by means of a traveling gantry crane, utilizing special hooks which automatically slip in and out of latches on the container or trailer.

Mechanically refrigerated cars incorporating a number of new features were built by Société Gregg D'Europe, S. A. Loth near Brussels, Belgium, associates of the Gregg Company, Ltd., New York, for use on the Saudi Government Railroad for transportation of frozen foods across the Arabian deserts. The car is a 40-ft, 50-ton capacity AAR standard car, steel-framed, steel-sheathed, and wood-lined with flush-type sliding side doors. To minimize heat transfer, 8 in. of fiberglas is used on the floors, sides and ends, and 10 in. in the ceiling. Aluminum roof sheets are used to reflect the heat, and the exteriors of the cars are painted chalk white to reflect heat away from the surfaces. A unique feature of the refrigeration equipment is the use of two-stage compressors because of the high ambient temperatures (125 F) prevailing throughout Arabia most of the year. An air-cooled diesel-electric generator supplies power to drive the two separate refrigeration systems, each operated at 40 per cent of rated capacity so as to give ample protection against failures. The two compressors in each car are special machines, designed by Worthington Corporation, combining two compression stages in one compressor.

Up to ten automobiles can be carried on the latest

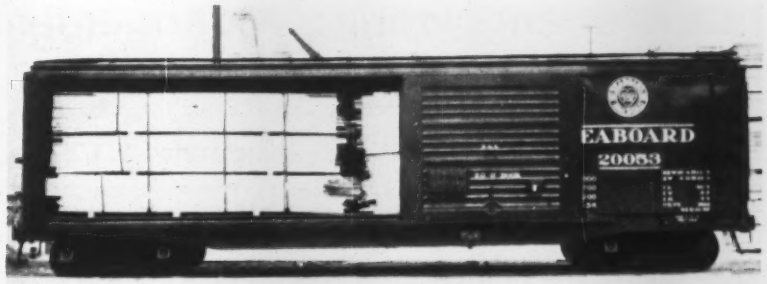


Fig. 27 SAL boxcar with 20-ft doors on either side giving free access to interior for rapid loading and unloading. This free access adapts the car to fork-lift loading and reduces costs to shipper and consignee.

German Federal Railways auto-carrying cars. The cars run on six wheels and are articulated in the center making the car as flexible as two four-wheel cars. There are two decks, and loading and unloading can be carried out without the use of cranes by the employment of ramps and built-in winches.

Journal-Bearing Problem. The freight-car journal-bearing problem continues to receive a great amount of study. The use of roller bearings is increasing and in the past year an unusually large number of lubricating devices for friction bearings have been brought to the market.

The Mechanical Division of the Association of American Railroads has spurred action in improving journal-bearing service by adopting three new rulings for friction bearings, as follows:

1 Effective March 1, 1956, prevailing loose fits or tolerances between solid journal bearings and axles were replaced by a system of controlled journal-bearing clearances. Three sizes of bearings designated as A-1, A-3, and A-5 have been adopted and axles will be turned to conforming dimensions. The dimensions and tolerances of the bearings and journals result in a clearance of 0.010 to 0.025 in., while the old tolerances permitted clearance of $^1/_8$ in. In the past, the same bearing was applied to all undersize axles. As fitted bearings will be applied on all new and rebuilt cars and in all repacked boxes, it is expected that within a period of 18 months, the present repack period, a large percentage of existing cars will have the controlled-clearance bearings.

2 Loose waste will be prohibited and an approved type of journal-lubricating device must be installed on cars built new, rebuilt, or receiving heavy repairs after September 1, 1957.

3 Effective January 1, 1960, all cars having plain bearings must be equipped with an approved type of journal-lubricating device.

New types of solid-bearing designs also have been introduced experimentally—one is the sealed-cartridge bearing unit introduced by the American Brake Shoe Company. This unit is a complete friction bearing fitted in a steel box with a lubricating pad so the cartridge or box can be installed in a standard friction journal box. The bearing proper encircles the journal and the box is provided with its oil reservoir and lubricant. It is designed to prevent misplacement during impacts.

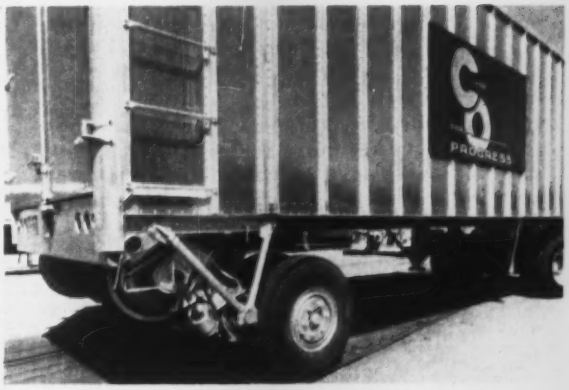


Fig. 28 Railvan designed by the C & O Railway which runs on either rails or highway

Acknowledgments

The Committee on Survey acknowledges with deep appreciation the assistance in procuring material for the report given by the *Railway Age*, *Railway Locomotives & Cars*, *Modern Railroads*, *The Railway Gazette*, *Diesel Railway Traction*, and by the railroads and the locomotive and car builders of Australia, Belgium, France, Germany, Great Britain, Japan, Switzerland, and the United States.

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Human Factors in Engineering Management

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The management of engineers is not a function unique in itself. The same principles developed by Taylor, Fayol, Gantt, and other pioneers of scientific management apply in the management of engineers as they do in the management of other people. We now accept without question the thesis of Fayol that any theory of administration which is valid cannot be limited in application—it must be equally applicable to all forms of organized human co-operation. We agree that management is a discrete function. Yet an engineer often is promoted to a management or supervisory position without being helped to discover that this responsibility must be separate and distinct from his engineering activity, and that it must be predominant to engineering.

We often get ready acceptance of the need for leadership without the understanding that it is not the simple matter of a dominating personality. By definition a leader must guide, influence actions, and create the climate in which his followers will produce in the amount and at the quality needed. One of our pressing duties as staff people is helping managers to achieve a greater awareness of this full leadership role. Too often a manager becomes engrossed in the mechanics of management—of creating and controlling a structure—and neglects the dynamics of management—inspiring and energizing the persons who are in his domain. Organization structure is nothing more than a means to the end of greater effectiveness and more productivity.

This structure must be shaped according to the best relationship of the persons involved. A business organization cannot be the static structure portrayed by a chart; it changes as individuals change. Managers must be alert to actual relationships and utilize them. The shifting stress of an organization must be recognized, and there must be constant adjustment to provide strength at shifting points of weakness. This accentuates a problem inherent in modern management, and especially that involving engineers.

Too often we think of an engineer as a member of a group, often a large group, rather than as an individual professional employee. He may even think of himself in the same way; the group identification may tend to deprive him of the personal satisfactions which he would enjoy as a lone professional. The struggle of engineers for true professional stature has increased the complexity of this problem. Our major concern is to see that these personal satisfactions are met and that each individual engineer receives proper recognition for his personal and technical contributions to the achievement of group goals.

Contributed by the Management Division and presented at the Fall Meeting, Denver, Colo., Sept. 10-12, 1956, of The American Society of Mechanical Engineers. Condensed from ASME Paper No. 56—F-12.

Productive Supervision

A large part of productive supervision lies in the area of good judgment, personal concern, and sound moral values. A tremendous improvement in the quality of supervision can be obtained just by sufficiently emphasizing responsibility for the solution of supervisory problems. Additional supervisory skills can be developed, but only in the company of supervisory and personal integrity.

Another significant question in the management of engineers is the degree of tolerance with which the quality and quantity of their work is viewed. This problem has become common throughout our modern culture. British social scientist Barbara Wooten recently pointed out that the concept of mental illness is expanding continually at the expense of the concept of moral fiber. She said, "Not long ago poverty, crime and other social evils were explained as the product of shiftlessness, extravagance, and indolence . . .; it was the moral delinquencies of individuals . . . which were held responsible for problems of social disorientation. Today culpability is out of fashion: the vogue is for traumatic experience . . . the truth of the matter is that today we have very little idea as to who is sick and who is sinful."

This very difficult problem faces us not only as citizens and in the field of mental hygiene, but in industry and specifically in the management of engineers.

There looms the important question: What should an employer expect of a professional engineer? The "Canons of Ethics for Engineers," published by Engineers' Council for Professional Development, set lofty standards for the engineer, but to what extent are we accepting shoddy performance?

For the answer we must look to ourselves and our concepts. Because of their preoccupation with technology, too many engineering supervisors pay too little attention to the supervision of people. But in how many cases have they been pushed to the other extreme without proper guidance? Just how good a job has been done in articulating quality standards? How well are they known and accepted? And how carefully have they been uniformly applied? Careful administration of performance standards provides one of the most effective means for reaching job satisfaction.

One of our divisions employing some 500 engineers has been particularly successful in the application of such quality standards. In our appraisal program each engineer's performance is discussed with him by his supervision at least annually. The engineer's performance is

compared with the requirements covering his own assignment.

Supervisor's opinions are reviewed with his line supervision. Both meritorious and inadequate performance are called to the engineer's attention as soon as noted, and reviewed during the appraisal interview. Considerable preparation insures that the appraisal discussion is frank and objective, and designed to assist. This is really a two-way discussion, providing the climate for healthy mutual analysis. Position descriptions are available to all, so each may learn the requirements of positions higher than he holds. As a result, personal development programs of these engineers are considerably more precise.

The development of engineers and supervisors is thus placed on a dynamic progressive basis. Successive appraisals disclose desirable changes in direction and emphasis of training. Management review of the appraisals provides criteria for judging the success of the entire personnel-development effort.

It is important that employees carry the responsibilities of their position and of themselves as normal men and women. It might appear that the way to insure this is to set as a goal, "helping employees help themselves." This would provide the optimum in learning opportunities, personal development, personal satisfaction, and moral growth. It is the way toward better-adjusted and hence better-producing employees.

Helping employees help themselves can become just another cliché unless worked out in each organization in terms of the group's climate.

Personnel Selection

We have developed no special immunization against that modern scourge—the shortage of qualified engineers. Rather than recruiting and simply turning new employees over to our five divisions, we try to encourage each division needing engineers to be active in the solution of its own problems.

We try to keep our staff personnel force as small as is consistent with the actual professional and clerical work required in recruitment. At the same time, we call on our divisions to provide active assistance, helping us screen applications, arranging for the reception of candidates, and in following up those to whom offers are made.

We find many values arising from this approach. Management thus becomes aware of the problems involved, an awareness which can only be obtained from direct contact with applicants. Our divisions are aware of the need for long-range planning for additions to their organization, to maintain proper balance in age groups, experience, and so on, and it is important that no feeling exist on their part that a staff organization is usurping their own management function.

There are other applications. In the administration of du Pont's employee-welfare plans, we apply the same philosophy of helping employees help themselves. We answer employees' questions concerning insurance only when they are related to the mechanics of coverage, encouraging employees to analyze their problems and make their own decisions concerning the propriety of coverage. Few treatments in the area of emotional adjustment compare favorably with personal achievements of this kind.

The catalytic function of a staff personnel organization can be seen in our Administrative Responsibilities Program. This is not a training program in the usual sense; it is "self-service," intended only to provide a framework for the solution of organization-relationship problems.

This program was begun because we felt that managers and supervisors faced the danger of losing "man-to-man" contacts with their employees. Important supervisory traits, such as leadership and creativeness, must not be replaced by statistical controls and a "supervise-by-the-book" attitude. The program provides a medium for the exchange of supervisory experiences, encourages more uniform practices, and helps improve these practices where needed.

Supervision Problems

Problems of relationships exist not only between supervisors and engineers, but also between each level of supervision and management. Accordingly, a uniform format was followed. Discussion started with meetings led by division managers. Each topic was then presented to each level of supervision in monthly sessions conducted by a supervisor at a level above those comprising the group. Each group included eight or ten supervisors.

Supervisors' work problems were developed by management representatives who took care to maintain a continuing review throughout their line organization. Basic outlines were developed, but special adaptation for each of the divisions was insisted upon to provide for individual problems. Major concerns were with clear understanding of responsibility and authority, individual recognition of engineers, and the whole area of communications. For instance, we found that our salary administration was accepted more on faith than on understanding. As a result, a rather complete statement on policy and procedure for our salary administration was developed and distributed to supervisors. Clear understanding, based on discussions of its implications by supervisors, has made a much healthier situation.

Problems were posed as questions, not as announced decisions, in an attempt to employ democratic methods without abdicating the responsibilities of line position. Problems were brought out in the open, carefully considered, and given deep thought. More often than not, solutions were reached.

New Viewpoints

There are many benefits which the program has not given us. But it has given management new viewpoints of supervisory problems; it has resulted in specific increases in delegation of authority. It has encouraged divisions to spell out their goals, and it has resulted in a clearer understanding of supervisory responsibility. By providing a wide exchange of information between management and supervision, it has broken barriers and established patterns which we see being given wide informal use.

The story of the management of engineers is the story of management. It is in no way debasing to engineers to treat them as humans first. That engineers are professional men makes them more sensitive to the strengths and shortcomings of management. For the same reason, they are much more apt to recognize that the true function of management is to achieve the goals of the organization by enhancing individual productivity.

In short, when we do a better job of managing, our engineers will do a better job of engineering.

Fabrication of Vulcanized Fiber

Methods of sawing, slotting, turning, drilling, tapping, shearing, punching, shaving, forming, finishing; suggested types of tools, speed, and feed; test values; limiting effects of heat and moisture

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VULCANIZED fiber is a chemically laminated cellulosic material of good physical and electrical characteristics. The oldest laminated plastic, it is still of basic importance to industry due to its unique combination of mechanical and electrical properties. Basic colors of material are gray, black, red, and white. Special colors can be produced.

The material is available in thicknesses from 0.004 to 2 in. in sheet form. It can be had in rolls or slit into coils 0.004–0.090 in. thick and up to 50 in. in width. Tubes of inside diameters $^1/_8$ to 4 in. and with wall thickness ranging from 0.020 to $^1/_2$ in., depending on the ID, are available. Selected sizes of tubes up to 18 in. ID can be made on stock equipment.

Advantages

Thirteen standard NEMA[1] grades and countless special varieties insure proper material for almost any application.

As an electrical insulator, vulcanized fiber provides good dielectric strength and outstanding arc resistance.

Tensile strength ranges from 6000 to 12,000 psi, depending on grade and direction of the grain. Flexural strength is 12,000–20,000 psi, while compressive strength is 20,000–30,000 psi. Shear strength is 11,000–15,000 psi, depending upon grade and thickness. Izod impact strength is 4–8 ft-lb per 1-in. notch. Rockwell hardness on the R scale is 60 to 100, depending on grade and finish. On hard-bone fiber, modulus of elasticity is 750,000. With these physical qualities at a density of 1.0 to 1.5, we have a material strong, tough, resilient, and weighing about one half as much as aluminum.

Disadvantages

With all of these good qualities and advantages, the material has marked limitations in two directions:

1 It is a cellulosic material and, as such, it is affected by heat. The effect of heat in a mild degree, 300 F or less for a short time, may be tolerated and is used in certain fabricating techniques. On the other hand, increasing temperatures, if maintained, result in effects as outlined in Fig. 1. Heat also causes a reduction in tensile strength and shear strength.

2 Again, as a cellulosic material, the vulcanized fiber has a marked affinity for moisture and tends to follow relative humidity in this respect. Fig. 2 shows the moisture content of vulcanized fiber in equilibrium with air of various relative humidities. Note that, at a normal relative humidity of 45 per cent, we have a moisture content of between 6 per cent and 7 per cent. This value is commonly considered as normal moisture content for vulcanized fiber.

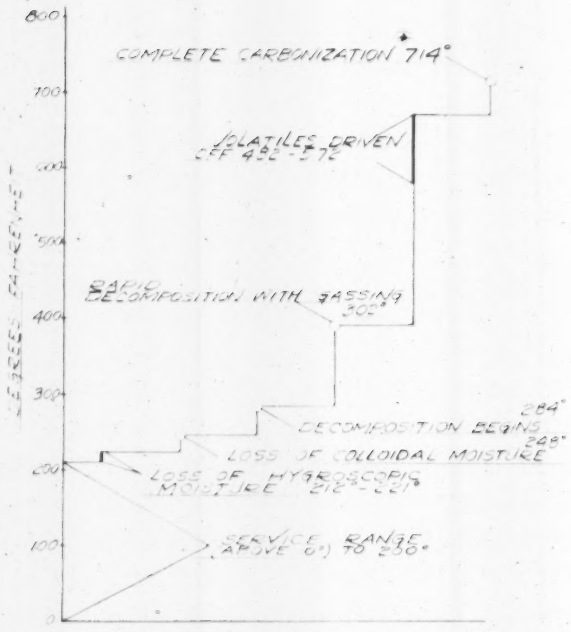

Fig. 1 Effect of increasing temperatures on vulcanized fiber

The importance of this hygroscopic quality of vulcanized fiber is found in the effect of varying moisture contents on physical and electrical qualities of the material. Fig. 3 shows this relationship as it affects impact strength, flexural strength, Rockwell hardness, and dielectric strength. Increasing moisture content is also accompanied by a slight reduction in density.

Fabrication

Machining of vulcanized fiber is commonly done by use of standard wood or metalworking tools. It is necessary to take into consideration the greater toughness and hardness of the material, and some adjustment of cutting edge and speeds, especially on woodworking tools, may be necessary.

[1] National Electrical Manufacturers Association.

Contributed by the Production Engineering Division and presented at the Annual Meeting, New York, N. Y., Nov. 25–30, 1956, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Paper No. 56—A-95.

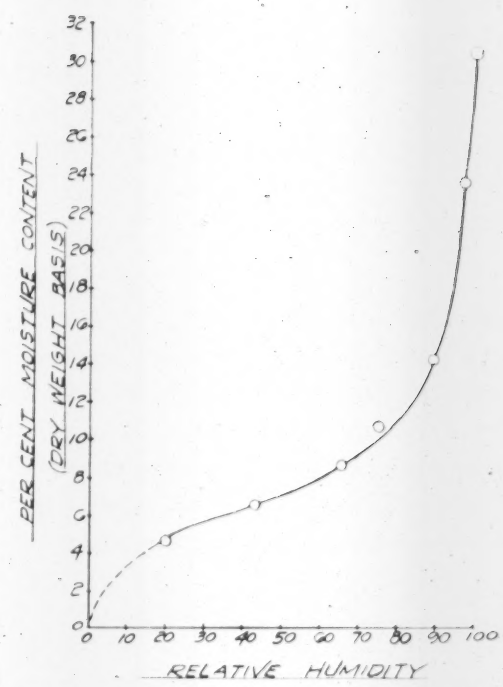

Fig. 2 Moisture content of vulcanized fiber in equilibrium with air of various relative humidities (at 25 C)

Sawing. Vulcanized fiber can be readily sawed. If the edge is not of particular importance, standard band saws may be used. Blade speeds of 4000–5000 fpm give good results. Due to the hardness of the material, it is sometimes difficult to maintain set on the saws, and for some applications, the use of full-hardened blades of the "skip-tooth" variety is indicated. Saws must be kept sharp to cut free and prevent overheating of both saw and material.

When the cut edge is of greater importance and must be smooth, good final results are obtained by the use of "smooth-cut" circular saws. This saw is hollow-ground, the teeth without set, and sharpened across the blade. Blades of $^1/_{16}$, $^3/_{32}$, $^1/_8$ in., and even greater thicknesses may be used, depending on the requirements. Diameters of saws range from 12 to 14 in. for normal applications with 4 to 6 teeth per in. Speeds range from 2700 to 3200 rpm (being the equivalent of approximately 10,000 fpm tooth speed). For long runs or close-tolerance work, the use of carbide-tipped saws may be justified.

Slotting. Slotting or contouring of fiber can be done on high-speed milling machines using high-speed-steel or carbide-tipped cutters. On milling machines, cutter speeds should be adjusted to give about 400 fpm peripheral speed, and feed should be adjusted depending on the type of cut. "Climb" milling may help to prevent delamination under unusually difficult conditions.

On high-speed miller, spindle speed will range from 3000 to 10,000 rpm, depending on the diameter of the cutter and the number of cutting edges. Feeds will vary from about 15 to 65 fpm. Finish of the milled edge is controlled primarily by varying the feed rate.

Turning. Turned parts are readily fabricated on metal-turning lathes or automatic screw machines. Lathe speeds vary from 900 fpm upward to 1800-fpm peripheral speed with feeds in the neighborhood of 0.011 in. Automatic screw machines of small size may operate with spindle speeds as high as 6500 rpm and adjusted downward as work diameters or machine sizes increase. When contouring a piece on automatic screw machines, feed should be approximately 0.001 in. per revolution; but on straight turning runs, it may be increased to as much as 0.005 in. per revolution.

Drilling. Fiber can be drilled freely if proper speeds and sharp drills are used. High-speed-steels or carbide-tipped drills will be found advantageous for long runs or close-tolerance work. Speed should range from approximately 6500 rpm for $^1/_{16}$-in-diam drill to approximately 3000 rpm for $^1/_2$-in. drill. It is essential, especially when drilling parallel to the laminations, that there be no "wedge" action from the drill, which might cause delamination. It is advisable to back the drill out frequently to cool the drill and to clear chips. Vulcanized fiber is resilient, and it may be found necessary to adjust drill diameters to obtain the desired diameter of the finished hole.

Tapping. This same resilience will be found to be a factor when tapping fiber. While standard metal taps can be used, it will be found that the ream should be 0.003 to 0.006 in. larger than the final diameter desired, due to the "springback" of the fiber. Tapping speed should be approximately 100 fpm. Special care is needed when tapping holes parallel with the laminations. It is advisable to clamp the piece to equalize stress and prevent splitting under such conditions. Fiber rod may be threaded on an engine lathe or automatic screw ma-

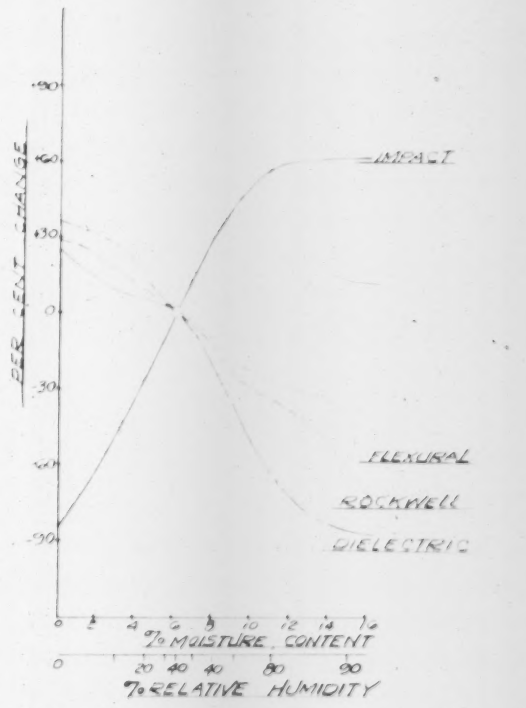

Fig. 3 Effect of varying moisture contents on physical and electrical properties of vulcanized fiber

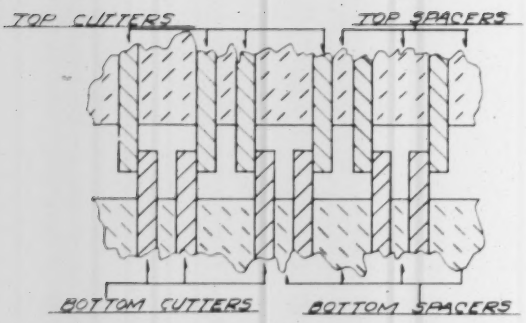

Fig. 4 Alternate setting of square-edge rotary slitter knives to minimize spiral on coils of heavy fiber

chine. Cutter or die must be kept sharp, and speeds equivalent to those for brass should prove satisfactory (in the range of 70 rpm).

Shearing and Slitting. Vulcanized fiber can be sheared and slit into strips or coils. For material up to 0.025 in. thickness, rotary knife slitters with bevel (or square) cutter edges give good results. For coils of material up to 0.090-in. thickness, the use of square-cut knives set in alternate positions, as indicated in Fig. 4, is essential if coils are to be free of twist or spiral. Knives must be sharp and set close if smooth thread-free edges are wanted.

Material from $^1/_{16}$ to $^1/_8$ in. thick can be cut with power-operated metal-squaring shears. A straight knife, sharp and close-set, will give clean edges up to this thickness. Material up to $^3/_8$-in. thickness may be rough-sheared on similar equipment of proper capacity, if the edge condition is not of primary importance. The fiber must have normal moisture content for good shearing or slitting. Overdry material will tend to check or crack along the edges, while excessive moisture will cause crushing, especially on heavier thicknesses.

Punching. Vulcanized fiber can be punched easily. It is possible to fabricate complicated pieces by use of compound dies or combination dies, while high-speed fabrication usually calls for progressive dies.

If the parts are being punched hot, due allowance must be made for the effect of temperature and for the material thickness, since fiber shrinks when cooling. For a $^1/_8$-in-diam hole in $^1/_{16}$-in-thick stock, the punch should be 0.003 or 0.005 in. oversize. For a $^1/_8$-in-diam hole in $^1/_8$-in-thick stock, the punch should be 0.012 to 0.015 in. oversize. Cold punching of simple parts produces good edges in thicknesses up to $^1/_4$ in., but complicated parts or heavier stock will give best results if preheated to about 180 F. It should be noted that the use of punches with a diameter less than the thickness of the stock is a condition which usually calls for special care, and adjustment of clearance or working temperatures may be necessary for good results.

Shaving. When comparatively simple components are needed with very smooth edges, a shaving die is frequently the economical answer. Shaving will produce smooth edges if the edge of the die is beveled at about 45 F for a distance of $1^1/_2$ to 2 times the thickness of the stock to be worked. Fiber up to 1 in. thick can be shaved cold, but frequently the use of preheat, even in this thickness, will give improved results. Heat is always needed on material over $1^1/_2$ in. thick.

Forming. Relatively thin sections of vulcanized fiber can be readily curved, bent, formed, and deep-drawn without sacrificing strength in the finished part. Usually, the first step is the proper plasticizing of the blank to be formed.

Although dry vulcanized fiber is essentially a set material below 250 F, it becomes moderately thermoplastic if heated to about 350 F for a period of 15 to 20 sec (for $^1/_{16}$-in. thickness). At this temperature, it can be post-formed into relatively simple shapes with moderate draw or bend, but the die must close quickly, and the piece must be cooled to below 250 F before removal if it is to retain its formed shape.

For more elaborate shapes and for the deeper draws, the fiber blank is softened by immersing it in hot water (160–210 F) or in a steam (saturated) chamber. The softening time is varied to suit conditions of thickness of material and shape and size of part to be formed. Some simple shapes can be formed by merely wiping the surface of the material with a moist cloth or sponge. Others of heavier fiber may require soaking for 30 min or even longer.

When sufficiently plasticized, the fiber is placed in a heated metal-forming die and held there for a time ranging from a few seconds to several minutes to "set" into shape. Die temperature, determined by the thickness of the material and the shape of the part, is usually in the range of 220–300 F.

Many simple shapes can be formed with pressures of about 200 psi based on the projected area of the part. Larger parts, such as circular covers, where only the periphery of the piece is to be formed, require calculation on the basis of the linear dimension of the circumference. This force rarely exceeds 700 lb per linear in.

The plasticity of wet vulcanized fiber is such that the material can be stretched about 25 per cent and compressed about 50 per cent. This means that a 3-in-diam disk can be drawn to a cup approximately $1^1/_2$ in. in diam by $1^1/_8$ in. deep. For a part roughly cubical in shape, depth of draw should be limited to about one third the length of the diagonal of one face. Depth of a spherical draw, as in the crown of a protective helmet or athletic-head-guard shell, can be about one half the average diameter of the opening with the possibility of extending this to 60 per cent under favorable conditions. While fiber of all thicknesses can be formed, considerable attention must be given to selection of proper thickness of stock and design of the forming dies.

Finishing. Finally, the material is impervious to most nonaqueous solutions, including gasoline, oils, and other petroleum products, and most organic solvents. This indicates that absorption of lacquers, enamel, varnish, or paint used for finishing will not be excessive and so results in reasonable finishing costs.

Summary

It must be understood that the foregoing information is, of necessity, of a general nature and that adjustment will have to be made for specific applications. However, an attempt has been made to present a fair picture of a tough, strong, resilient material of good electrical properties and moderate cost, capable of being easily fabricated, and of long-standing interest to industry. As a basic industrial material, vulcanized fiber holds its own in face of competition from newer plastics, and constantly finds new applications where its qualities can fill all requirements.

Graduate Study in Mechanical Engineering

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The current demand for the graduating seniors at our engineering colleges has perhaps obscured some of the developments which have been taking place in postgraduate education. Industry (1)[1] has shown a tremendous interest in the advanced education of engineers, and has spent large sums of money on fellowships and on programs designed to encourage engineering employees to undertake graduate study. In view of the accelerating tempo of such company programs it is appropriate to pause and examine the reasons for graduate study in mechanical engineering. As preparation for modern industry and engineering, graduate study is neither a fetish nor a frill. It represents one facet of a requirement for national survival.

If graduate work is to be undertaken, the following questions should be answered: Why? When? What sort? How?

Why Undertake Graduate Study?

In a paper which was both lucid and prophetic, A. G. Christie (2) outlined the desirability for graduate study and called upon industry to underwrite the effort. One might wish that sixteen years ago our corporations had been as receptive to this call as they seem to be now. He suggested that the principal things to be gained from postgraduate education were: (*a*) Self-reliance based upon more thorough technical instruction, leading to (*b*) aggressive initiation in invention, design, and the introduction of new methods.

Today there is an appreciation for the value of graduate study on the part of industry and also by the young men entering the engineering profession. Both groups understand that advanced education is one of the keys which will open the way to new techniques and new products.

In an effort to answer the question "Why should graduate work be undertaken?" we should feel safe in listing

To gain a sounder grasp of the fundamentals learned as an undergraduate.

To stimulate the student to creative thinking.

To give the student advanced professional or application courses.

To help him to understand new technological developments.

If it may be assumed that the case for further education has been established, what form shall it take? One industrialist (3) has indicated that there are at least three directions that may be followed:

Technical or scientific.

Business, including such areas as economics, accounting, law, and so forth.

Social sciences, and the humanities.

He has cautioned young men that it will not be good enough in the future merely to grow with the company, and that it is up to the individual man to formulate a program of positive action for his own professional development.

An educator (4) has presented a complementary point of view. He indicates that the overwhelming number of men who go through graduate school enter industry. As a result, industry should claim a part in the planning of the graduate work and should be prepared to render moral support and financial assistance to the student. He feels that each graduate program should be "tailor made," and that the curriculum is less important than the manner in which it is presented.

There is general agreement that graduate courses should be "rigorous," "thorough," "complete," and "comprehensive," and that only "top-notch" teachers should be permitted to conduct classes. There is less agreement as to the type of subject matter. At least one man (5) has taken a stand in favor of engineering science as opposed to a mere accumulation of specialized courses in mathematics, chemistry, and physics. It is not that he deprecates the value of these basic courses. He urges that the need in industry is for the solution of pressing technical problems by a combination of disciplines. The approach, in his opinion, is to have high-level courses of the engineering-science type taught by men currently at work in both education and industry.

A review of the traditional practices in graduate education is in order at this point. Although there are some recognized postgraduate curriculums not designed for the master's or doctor's degree, they are few in number. Some colleges accept graduate students on a nondegree basis, permitting the man to choose courses which he feels may be useful to him in his work.

The master's degree has been the subject of very different attitudes when viewed by the scientific and engineering faculties. In most cases it has been considered a terminal degree for the engineers.

Among the pure sciences the master's degree generally has come to be considered a mere way station preceding the doctorate. In some institutions the science student works directly for the doctor's degree without qualifying for the master's. There are some university departments in which the master's degree is cynically regarded as a sort of "consolation prize" for the men who are denied the privilege of continuing toward the doctorate.

Currently there are demands for both the scientific and the traditional master's programs among engineers. In the terminal master's program there is room for more

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

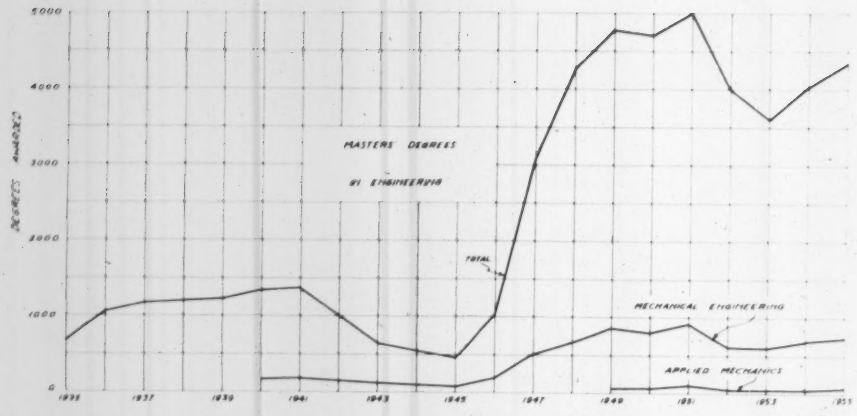

Fig. 1 Master's degrees awarded during the years from 1935 to 1955

professional and application-type courses designed as immediate preparation for current engineering practice. In the predoctoral curriculum the problem is the assembly of an analytical "tool kit" which will serve later in the pursuit of a research degree.

There is at least some interest among our educators in a few master's programs that are designed to strengthen a knowledge of fundamentals by offering broad curriculums that cut across departmental lines. This has been done in the Naval Ordnance program at Purdue (6) and in the Computer Curriculum at Stevens, to cite but two examples.

At the master's level, then, there are at least four types of curriculums which may be followed.

A terminal degree program with emphasis on depth in a relatively narrow area, and designed for the needs of engineering practice as they are known today.

A terminal degree program with a broad sampling of technical areas, but keyed to some central theme.

A terminal degree program in a field cognate to that in which the baccalaureate was taken.

A degree curriculum designed to equip the student for further work of a research nature.

In any or all of the foregoing programs a thesis might or might not be required.

Doctoral work is expensive for both the student and the institution. The student has a large bill for tuition and fees and must support himself for three or four years. The college must furnish responsible supervision, commit valuable equipment to his exclusive use, and supply skilled labor, materials, and services.

In order to find the funds for doctoral work, an increasing number of colleges have turned to sponsored research. Superficially, this appears a satisfactory and easy solution; actually, great difficulties attend it (7). There is the problem of gaging the contract work to the staff and facilities of the institution, and then of ascertaining what parts of the work would be suitable for thesis problems. Involved also are patent and publication rights which may have the effect of delaying the distribution of the dissertation. In some cases secret work is done and the dissertation may never be published because date are classified.

Doctoral programs vary with the institutions. However, there is no such thing as a doctorate designed for current practice, nor even for increasing fundamental knowledge in a group of fields. Although both of these areas are served incidentally, the main objective is to train the man for research. Generally, an experimental investigation is required.

The question "What sort of graduate education?" might be answered by one or more of the following.

Individual courses of an advanced scientific or engineering nature and related to professional employment.

Undergraduate or graduate courses taken in a related area.

Courses taken for cultural value.

A co-ordinated postgraduate course sequence to develop understanding of a given technical area, but not leading to a degree.

A curriculum leading to a master's degree with either broad or narrow specialization.

A doctoral program.

When Should Graduate Work Be Undertaken?

It has been pointed out that it is desirable that the student have some industrial experience prior to, or concurrent with, his graduate work (2, 5). In general, however, advanced study should be started as early as possible. The problem is largely one of economics in which a balance must be struck between time and cost of education on the one hand, and temporary loss of earning power on the other.

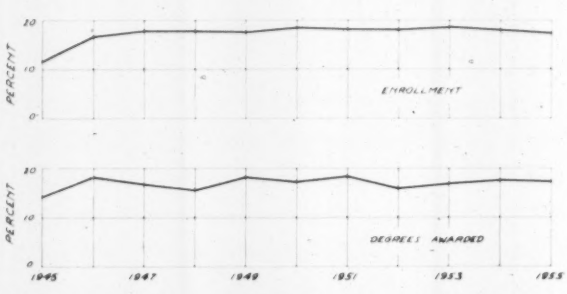

Fig. 2 (*a*) Enrollment for the master's degree in mechanical engineering as a percentage of the National enrollment for the master's degree in all branches of engineering. (*b*) Master's degrees awarded in mechanical engineering as a percentage of the national awards in all branches of engineering.

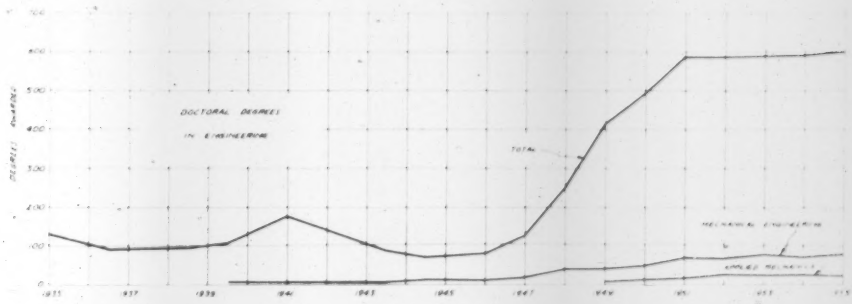

Fig. 3 Doctoral degrees awarded, 1935–1955

How Shall Graduate Study Be Undertaken?

Traditionally our full-time graduate students were either on fellowships or had some outside support. Recently some corporations have arranged to hire young men, then assign them to full-time graduate study at a university; others have done this after a period of years of company service. Neither arrangement is common, however. Opportunities for part-time graduate study are generally available to graduate teaching assistants, research assistants, and junior faculty. In some cases, corporations have permitted engineering employees to take university courses on company time during the day.

In the metropolitan areas an increasing proportion of the graduate courses are offered at night. In some cases, part or full payment of tuition is being contributed by the companies which employ the engineers. A survey of the enrollment figures of the American Society for Engineering Education does not show any conclusive evidence that night courses will predominate in the future. The day enrollments for the master's degree reached a maximum of 76 per cent during the post-World War II boom in 1946, then dropped off to 33 per cent in 1951. Since that time, day enrollments have risen steadily, reaching 49 per cent in 1955.

It is almost impossible to work out a satisfactory doctor's program on a part-time evening basis. The very nature of doctoral research calls for the fullest concentration and application on the part of the student. Some companies have arranged a leave of absence for the student with part or full salary during the time he is doing his research. This practice is not common, however, and it would seem desirable to investigate ways and means for supporting a candidate while he is doing his doctoral research.

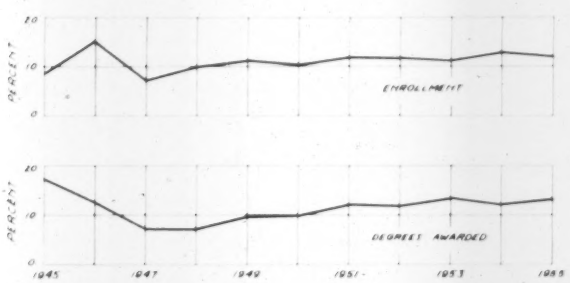

Fig. 4 (*a*) Doctoral enrollment in mechanical engineering as a percentage of national enrollment for the doctorate in all branches of engineering. (*b*) Doctoral degrees awarded in mechanical engineering as a percentage of the doctorates awarded in all branches of engineering.

What Is Our Past Performance?

In the American tradition, our educational system has been geared to the benefit of the individual rather than to the needs of the state (8). By the same token, the individual student has had the responsibility for planning and for financing his graduate education.

Using data on male students from the journal of the American Society for Engineering Education, the twenty-year trend in the award of master's degrees has been plotted in Fig. 1. The peak year was 1951 when 4993 master's degrees were granted in all areas of engineering. It is interesting to note that the postwar boom did not fade out as one might have expected. In very round numbers, there are about four times as many men earning master's degrees as in the prewar period.

Data on the years 1935–1940 were not available to show the trend in master's degrees in mechanical engineering. The history for the years since 1940 is revealed in Fig. 1. Separate data on applied mechanics have been available since 1949. This has been included as an area that might have absorbed some of the men who would normally have taken the master's degree in mechanical engineering.

A quick appraisal of the mechanical-engineering master's trend over the past decade can be obtained from Fig. 2. For about nine years the enrollment has been almost constant at about 17 per cent. An approximately constant percentage of degrees has been awarded over the same period.

In Fig. 3 the awards of engineering doctorates are shown over the past twenty years. It is interesting to note that since 1945 there has been a continued rise in the number of doctoral degrees awarded. It is encouraging to note that there is about a six-to-one increase in doctorates over the prewar period. Steady increases are also shown for the doctor's degrees awarded in mechanical engineering and in applied mechanics.

The trends in doctoral enrollment and degrees awarded in mechanical engineering are shown in Fig. 4. An upward tendency has been maintained since about 1948 in each category.

To this observer, past performance looks good. It is a credit to our young men that they had sufficient faith in the advantages of graduate education to complete degree programs. Though many were aided by the G.I. Bill, each of the men who qualified for advanced degrees in the postwar period did so at a considerable personal sacrifice. These men have shown that they do

possess the spirit of the profession and the determination to see things through. Among them we will find those whom Dr. Julius Stratton (9) has termed the "statesmen and leaders of the profession" during the years ahead. The fact that large enrollments have persisted since the postwar veteran boom is an encouraging sign for both engineering and education.

What of the Future?

The shortage of engineers and scientists is currently recognized as a major national issue. An equally serious problem is that of finding the faculties to instruct our young men (10). To solve these problems we should enlist the services of the ablest men in the country.

The expansion in engineering education which has already taken place was due to several factors including

The G.I. Bill.

A liberalization of the attitude of industry toward graduate study.

An accelerated pace on the part of the universities in extending and improving graduate offerings.

A beginning on the part of industry toward subsidization of graduate students.

Recognition by the government of the need to support graduate students.

Conviction on the part of the student of the usefulness of advanced work.

Except for the first item, all of the factors cited will continue to have an expansive effect on the growth of graduate study in engineering. Greater federal and state aid will be forthcoming as the electorate and the legislators become aware of the technical needs of the nation.

The real key to the situation, however, is the part that industry is willing to take. Support from this source must be generous. College and industry must be made to realize their interdependence and must work out patterns which will honestly serve enlightened self-interest and not confuse it with altruism.

In addition to direct subsidization in the form of fellowships, grants, and research contracts, the government could contribute indirectly by enacting tax legislation designed to promote industrial co-operation with the colleges.

Conclusions

1 Graduate study in mechanical engineering is no longer regarded as "overspecialization" or as an outlet for academic curiosity. It has achieved a status comparable to that of other scientific fields.

2 There is need for a wider understanding of the utility of graduate study and of the potential value that it has for the entire nation.

3 In the future, graduate students will be given more encouragement and will find more adequate financial support. However, the students must be prepared for the hard work and personal sacrifices which graduate study will continue to require. Professional development, like salvation, is an individual matter.

4 The great expansion which has taken place in graduate education has been due to the pressures of the engineering profession, the needs of industry, and the conviction of the students that this was desirable.

5 Further expansion of the opportunities for graduate study is needed, and this must be primarily the responsibility of industry. "Incentive" tax arrangements would permit industry to join in a fuller partnership from which the students, the industries, and the nation would benefit.

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Affiliation of ECPD and EJC

The Engineers' Council for Professional Development voted on the subject of affiliation of ECPD and EJC at the 24th Annual Meeting in Detroit, October 25–26, 1956, instructing the Planning Committee to undertake further study in co-operation with the Planning Committee of EJC. The vote was on the basis of the following report submitted by the ECPD Planning Committee.

An eventual combination of EJC and ECPD is important for the following reasons:

1 The objectives of the two organizations are in a broad sense much the same.

2 There is much confusion in the minds of engineers generally and the governing boards of the constituent societies of both groups particularly, concerning the difference between the organizations and the reasons for having two such groups in the engineering field.

3 Many societies are members of both EJC and ECPD. These societies are confronted with two budgets and two appropriations which look to the Boards of these Societies to be devoted to the same ends. This apparent duplication jeopardizes the financial support and stability of both organizations.

4 Some overlapping exists in the activities of ECPD and EJC. Several joint committees are in being, and at times it is difficult to decide which organization should handle a specific situation.

5 ECPD has evolved in a definite functional pattern. It guides the young engineer from high school into an engineering college, follows him through college, and guides him through the first few years after graduation until he is ready to become a licensed engineer or is eligible to join an engineering society as a full member. ECPD advises engineering colleges and accredits their curricula. These ECPD functions can readily be discharged in a combined organization. It has not been found necessary nor desirable to expand the activities of ECPD beyond this area.

6 EJC activities are more general. They cover the rest of the engineering field not occupied by ECPD. EJC is tending to operate through the functional organizations such as the Manpower Commission to which are assigned large areas of engineering activity. These functional groups have their own offices, staff, committees, and procedures authorized by EJC.

DEVELOPMENTS IN

Plastics Engineering . . . 1955-1956

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In reviewing the developments in plastics engineering over the past twelve months, one is immediately impressed with the very great activity in this field. Research and development groups are producing new materials and new products at such a rate that management is faced with an unusual problem. Will something even better be discovered during the time required to put the latest new development into production? Fortunately the predicted market for plastics is so great that little risk is taken by going into production with a new product even though research gives an indication that a superior product will be forthcoming in the near future.

THE plastics industry is currently producing at the rate of about 3.4 billion pounds per year (1)[1]; compared with 2.7 billion pounds, last year, an increase of 26 per cent. The average rate of growth of the more important plastic materials from 1949 to 1955 was approximately 22 per cent per year. Hence the last twelve months have not only shown a growth in the plastics industry but a growth at an increasing rate.

A straight-line projection of the current rate of growth would indicate a production in 1960 of 8.5 billion pounds. A rate of growth so far in excess of our population growth is somewhat unrealistic. A more meaningful estimate, considering the loss or growth of markets and sociological trends, places the 1960 production rate at about 7.2 billion pounds (2). Which of these predictions is more accurate is a matter of opinion. It should be borne in mind that at this time last year the best estimate placed the 1960 production at 6.0 billion pounds, far below either of the two predictions made at this time.

The average consumer level price per lb for resins and molding materials is about 50 cents. At the current production rate this means an annual dollar volume of 1.8 billion or about one half of one per cent of our gross national product.

In addition to the growth of production other trends of the plastics industry are worthy of note. Sharp price reductions for some resins have taken place. In some cases this has been due to greater local production, resulting in economies and in other cases foreign competition has had an effect. The trend, in evidence a year ago, toward the acquisition by materials producers of captive markets by the purchase of existing finished-product-producing facilities has continued.

The optimistic prospects for the plastics industry have continued to attract companies with excess capital who wish to diversify. Mergers and consolidations between existing companies have continued at a rate which would indicate that, in the future, production of plastic materials will be centered in a rather small number of large companies. During the past six months the announcement of more than 65 major expansions in production facilities has been made by plastics producing companies.

Activities in the plastic industry abroad indicate a trend similar to that found in this country. In 1955 British exports of plastics were 20 per cent higher than 1954. Imports were up 50 per cent with vinyl resins accounting for 45 per cent of the total. German producers of plastics have undertaken large expansion programs which have resulted in a 1955 production of approximately 400,000 tons. Major new production facilities for subsidiaries of American companies are under construction in Australia, Scotland, Spain, Brazil, and India. The directives issued for the USSR's Sixth Five Year Plan call for a sharp increase in the use of plastics. Russian research institutes are under heavy pressure to find new applications for plastics in everything from automobile bodies to household items.

Materials Developments

As in the past, the materials producers have continued to bring forth new polymers and modifications of the older more-established materials. In many cases older plastics have been so improved by new polymerization techniques and new formulations that they should be thought of as new materials. Re-evaluation of the properties of polymers associated with their chemical names should be undertaken by all consumers.

Among those materials in which marked improvements have been made are epoxy resins, polyvinyl chloride, polyesters, nylon, and polyethylene.

New curing agents for epoxy resins have been developed which combine good heat resistance with high strength, thereby improving the usefulness of this material in forming dies and tools for the metal industry. Modified epoxies with pot lives of up to eight days are being found particularly useful in electronic impregnation and encapsulation uses. For use in the laminating field, epoxy resins with very low viscosity have been developed to increase the ease of penetration of the filler by the resin. For applications where run-out is a prob-

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Rubber and Plastics Division and presented at the Annual Meeting, Nov. 25–30, 1956, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from ASME Paper No. 56—A-183.

lem, thiotropic agents can be added to the basic material.

Polyvinyl chloride resins and formulations have been modified to produce a variety of special purpose material (3). Vinyl polymers are now on the market which can be easily extruded or injection-molded even though unplasticized. New plastisols for spray coating can now be applied even on vertical surfaces without application of heat and with little danger of sag or run. Plasticizers for exceptional low-temperature flexibility have been developed and stabilizers have been produced that improve the aging properties of formulations containing heat-sensitive organic pigments. Research emphasis continues to be directed toward the production of vinyl chloride copolymers with flexibility comparable to the highly plasticized formulations.

Polyester resins blended with monomeric methyl methacrylate and styrene have been developed with which highly transparent glass-reinforced laminates can be produced. These formulations are designed to resist discoloration by ultraviolet light and to have refractive indices closely approaching that of glass thereby increasing the transparency of the laminate. Premix polyester resins for combination with reinforcing material by the molder permit rapid molding of intricate parts in matched metal dies.

The number of reinforcing materials for use with low-pressure laminating resins has been increased by the addition of improved synthetic fiber mats. Nonwoven, mechanically bonded mats or blankets of nylon, acrylic, or polyester fibers permit equal strength in all directions in the finished laminate. In many cases, the ability of such batting to be deep-drawn eliminates the need for preforms and increases post-formability.

Phenolic molding compounds have been improved by the development of faster curing materials with excellent flow characteristics. With these formulations extremely fast molding cycles can be used to produce a product of high-gloss surface finish.

Nylon continues to gain a larger and larger proportion of the mechanical applications of plastics (4). An interesting development in this material is the production of a molybdenum-disulphide-filled nylon molding powder for use in applications such as bearings where superior wear and frictional properties are required.

Twelve months ago the developments in ethylene polymers captured the attention of the entire plastics industry. Today the interest in these materials continues unabated. Polyethylenes of the high-density type are now on the market. Plans have been announced for the construction of large facilities for the production of this material by the two low-pressure processes, and for increased production facilities for the manufacture of conventional polyethylene by the high-pressure process. A method for producing the rigid high-density material in existing high-pressure equipment has been announced.

The number of different conventional polyethylene types continues to grow with special formulations for electrical applications, films, and molding materials. Different molecular weight resins have been found desirable for specialized applications, and the addition of antioxidants and carbon black have improved the aging characteristics.

As the high-density or linear polyethylenes come on the market it is becoming apparent that the different polymerization methods produce polymers with different properties. The customer will have to evaluate each one to find the one best for his application. Molders are also becoming aware of the need for different molding conditions for each of these materials.

Considerable discussion has centered around the relative merits of the high and low-pressure ethylene polymers (5) from both the use and fabrication points of view. A general consensus of opinion seems to indicate that each type will have application for the properties in which it excels and in view of the expanding market competitive applications will not cut into the tonnage requirements of either type for some time.

In connection with this family of plastics, another controversial issue has caused considerable debate and much editorial writing — the question of how to refer to these two types in general without mentioning trade names.

A new family of styrene polymers has been announced. A method has been found to produce methylstyrene with reasonable yields of the ortho isomer (6). Increasing the amount of the ortho isomer raises the softening point. A 100 per cent ortho isomer is reported to have a heat-distortion point of 110 C. In addition to greater heat resistance, methylstyrene exhibits less shrinkage than styrene at elevated temperatures. Copolymerization of methylstyrene with acrylonitrile produces polymers with improved toughness and abrasion resistance. These materials should not only upgrade the quality of moldings in many applications but should also open up new fields of application.

Polypropylene polymers, although announced some time ago, have finally been described in detail (7). By the use of a heterogeneous catalyst consisting of a combination of metal alkyl and a metal halide, yields of as high as 90 to 95 per cent have been obtained. In the resulting polypropylene all of the monomeric units have the same steric configuration of the assymetric carbon atoms. As a result, products of high crystallinity are obtained. Polypropylene has a melting point of about 320 F compared to 250 F for the linear polyethylene. Other advantages include greater solvent resistance and a non-waxy feel. The current price of propylene is about one fifth that of ethylene. Even though a large demand for propylene may change this price picture, this new material is expected to be very competitive to the film, fiber, and molding-materials markets.

The same polymerization methods have been found to be successful also with butylene, butadiene, and styrene. Very little information is yet available on these developments but obviously their commercial possibilities are quite intriguing.

Fabrication Processes

Replacement of the conventional torpedo by a new perforated "polyliner" has been shown to increase injection-machine capacity and to provide more uniform melt temperatures (8). The new device consists of a long hollow cylinder with ribs on the outside for metal-to-metal contact with the machine-barrel walls and radial holes for the passage of the plastic from the inside of the cylinder to the outside. The metal-to-metal contact provides good heat transfer to the polyliner and the forcing of the plastics material through the radial holes increases the opportunity for heat to flow into the molding material. The use of the "polyliner" has resulted in increases in production rates of over 100 per cent in some cases.

In another similar development (9), the heating cham-

ber is designed so that the polymer passes through the heating surfaces as soon as it melts away, bringing new cold material against the hot surfaces.

Good plasticizing, even with conventional cylinders plus fast-acting machines and very cool molds, has made possible complete molding cycles of only a few seconds. Such production rates as this permit the injection molding of such throwaway items as disposable cups and plates.

Advances in equipment and technique have reduced the cost of thermosetting molding operations considerably (10). Automatic equipment has been developed for compression or transfer molding even when inserts are to be used. With the use of faster-curing materials, preheating of feeds, and faster-acting machines incorporating the current developments in automation, rates of production have been greatly increased.

In the extrusion field, a new development in screw design permits greater production and the fabrication of high-quality products from the less-expensive grades of materials (11). This new process of extraction extruding employs a hollow screw with a feeding zone, a compression zone, a metering zone, an extraction zone, another compression zone, and a pumping zone. The volatiles given off by hygroscopic plastics are removed by a vacuum through holes in the hollow screw in the starved portion of the extraction zone.

The principle of adiabatic extrusion has been advocated for some time. Its advantages are based on expectations of greater production rates from smaller machines, less power requirement, and more uniform plasticizing of material. We now have machines on the market designed to operate on this principle.

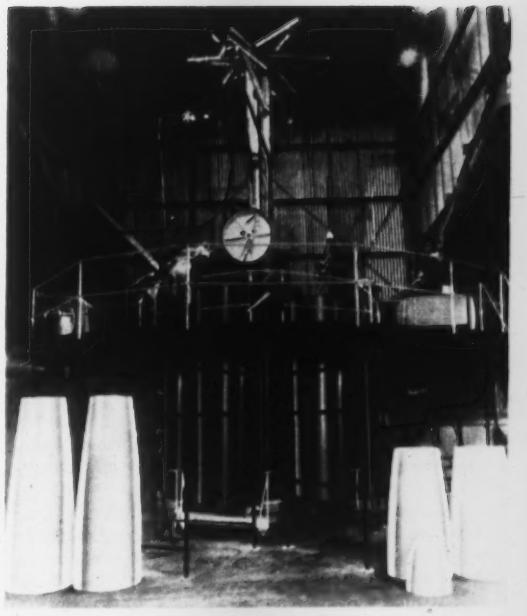
For the first time in several years, a radically new type of extruding machine has been placed on the market. A short hollow screw is used to plasticize the material. At the discharge end a heated-cone baffle forces the melt through holes into the hollow center of the screw. An air-operated plunger inside the hollow screw maintains a constant pressure on the material as it is forced through the die. This method is reported to reduce greatly surge or oscillations in the flow of material.

The vacuum-forming field has turned to increased automation to enlarge production and reduce costs. Deeper draws and better quality products are being produced by various plunger-assisted types of operations. The technique of direct-vacuum forming on the hot sheet as it comes out of the extruder has been put into successful operation by several producers. This results in some saving in power and increases production rates by eliminating the tying in of production cycles to the rate of heating of individual, previously formed sheets. This method of fabrication is expected to give competition to injection molding especially on large volume items such as disposable cups.

Engineering Developments

Research has continued to add to our knowledge of the properties of plastics and application of this knowledge to design and fabrication has led to better-engineered plastic items.

Several studies (12, 13) have been reported on the impact properties of molded items and films. Use of these developments should lead to better quality control and more intelligent choice of materials. A simple method of converting the standard Izod test to use a tensile type



"Carousel," Patushin Aviation Corporation's machine for forming cylindrical shapes as large as 10 ft long by 44 in. in diam from glass fiber resin. One plastic cylinder is produced every ten minutes by a single operator.

of loading (14) makes possible a more meaningful interpretation of data and should give some valuable information even though only one rate of straining is used.

A careful analysis of the heat-distortion test has brought forth the effects of test method, specimen conditioning, and material composition on the test results (15). Techniques for studying the surface deterioration, crazing, and creep deformation of plastics subjected to outdoor weathering under stress have been demonstrated (16). A low-amplitude vibrational test has proved satisfactory as a nondestructive method of measuring the decline of mechanical properties due to degradation (17).

Reinforced plastics have been the subject of several engineering studies. An analysis of the effect of the various properties of the resins and fillers on the properties of the final laminate has been made (18). A mathematical relationship is obtained for the tensile modulus of elasticity. The effect of prestressing reinforcing materials during the laminating process has been studied (19). A fifty per cent increase in flexural strength in the direction of prestressing can be developed by this method.

The effect of atomic irradiation on polymers has continued to be the subject of extensive study. Beneficial effects have been observed on some materials and detrimental effects on others. Interpretation of the observed changes in mechanical properties in terms of the underlying reactions which occur has been attempted (20).

In order to design fabricating equipment and cycles on a more sound engineering basis, investigations of the flow characteristics of melts have been the subject of much interest (21). A new concept of the cause of irregularity in extrusions has been based on consideration of a

critical stress beyond which tearing or fracture of the molten polymer appears (22).

Continuation of this trend toward fundamental studies of the problem underlying plastics application and fabrication will undoubtedly lead to the eventual development of the science of plastics engineering.

New Applications

It would be impossible to list all of the new applications of plastics during the last twelve months. Space permits the mention of only a few of the most important and unique developments.

A plastic house of unusual design is under construction. Leaving behind the tradition-bound concept of architectural engineering this revolutionary house uses a one-piece-molded 8 ft × 16-ft module which forms the ceiling walls and floor of the living wings, cantilevered out from a 16-ft-sq central utility core (23). The use of polyethylene film as a vapor barrier in house construction has every indication of becoming a very important market.

The patching of metal, wood, and concrete products with an epoxy-metal formulation is expected to increase public appreciation of the usefulness of plastics. Disposable jet-plane fuel tanks of reinforced plastic have been put in use as well as glass-fiber-reinforced pressure vessels for the storage of gases.

The automotive field has continued to find new applications for plastics with about ten pounds going into each 1955 car. An interesting side-light to the increased use of plastics in automobiles is the development of glass-reinforced, child-size models of current production cars.

The packaging and sign industries continue to hold the spotlight as potentially large new markets for plastics. The vacuum-forming process can now be used for deep-draw inexpensive packaging operations. Two methods have been developed to produce the illusion of motion in three-dimensional display signs.

Houseware of both thermosetting and thermoplastic materials has found increasing markets. New and better designs coupled with proper material selection have enlarged consumer demand. Gardening will soon be simplified by the use of plastic sheeting around plants to prevent the growth of weeds.

Foams of all types are finding their way into the furniture and appliance fields. Rigid foams are being used as heat, sound, and moisture insulation in the building industry.

Areas which seem to hold the largest potential growth for application of plastics are the automotive field, packaging, electronic and communications equipment, furniture, housewares, and appliances.

In view of the increase in leisure time among the younger age groups many new applications should be expected. For example it is predicted that over 250,000 swimming pools will be in use by 1960. This growth is expected to be based on the use of vinyl sheeting or glass-reinforced plastics for liners.

Society Activities

The engineering societies continue to sponsor and promote engineering progress. Symposia and programs devoted to plastics have continued to increase in number. The establishment of standards for materials and specifications for products are rapidly being formulated and established through the tireless efforts of many individuals under the auspices of the several engineering societies.

The Society of Plastics Engineers is currently undertaking the preparation and publication of several books on the various aspects of plastics engineering.

Educational programs at all levels are being initiated to promote better engineering and technology. The industry, through individual efforts and society activities, is making every attempt to interest prospective students in engineering and science, and to improve the deplorable lack of mathematics and science training in our high schools.

The industry held the 7th National Plastics Exhibit in New York in June. From all indications, the spirit of enthusiasm and great public interest in evidence at this show insures a bright and prosperous future for plastics and plastics engineering.

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Are Engineers Underpaid?

A panel discussion on the rewards of engineering, with a statistical analysis

The Problem[2]

This particular question presents a problem with innumerable facets, and the subject matter should be, "Are Engineering Efforts Adequately Rewarded?"

Having established a broader base for this discussion, we should define the particular group we are considering.

When we speak of an engineer, we are speaking of an individual who has attained, or possesses the faculties to attain, professional status. In engineering, this is related to that level where an individual, because of scientific training and experience, is capable of assuming the responsibility for design of a project. This will help us understand the complexity of this problem, since design is required for a small machine part as well as a large power-plant installation, and the degree of ability and responsibility for these two projects is quite different.

The rate of remuneration for a position will also vary from one company to another, in different parts of the country, and for similar positions in the same locality. These discrepancies are generally dictated by need, since the rate of pay for engineering service is governed by the law of supply and demand, the same as any other commodity.

One Founder Society recently proposed four different methods for evaluating engineering work. They also suggested several variations of the four basic methods, each of which was intended to give a similar answer.

Several years ago one state society recommended a minimum salary of $4000 per year, with no attempt to specify minimum salaries for successively higher grades of professional service.

Other Rewards

There are, of course, some other rewards for engineering effort. The engineer has attained a moderately comfortable standard of living, and the rewards beyond these physical things cannot be overlooked. Number one is the satisfaction of his job. An engineer is an imaginative person who has the opportunity of expressing his thinking in a concrete manner. Having a pioneer spirit, he derives considerable pleasure from having created, or bettered, some item which benefits mankind.

Reward number two is the engineer's freedom, being generally permitted to devise his own methods and create his own solutions for most of the work he performs with a minimum of restraint on his initiative.

Last, but not least, we should consider the opportunities afforded the engineer for management positions. His mind has been trained to thoroughly analyze a problem, logically select a method of solution, and develop an accurate answer. This type of thinking is extremely valuable to our modern complex business system where management is looking for properly-adjusted engineering minds to assume the responsibility of directing our vast industrial system.

Yet the engineers who succeed in reaching these higher levels of success are somewhat in the minority, due to one failing which engineers generally do not avoid. We have been trained both in our schooling and our experience that there is only one answer which gives the best result for any problem. This type of thinking tends to narrow our viewpoint and is not necessarily conducive to good management.

Supply and Demand

Engineering services, as has been stated, are subject to the law of supply and demand. We all know that anything in short supply tends to command a premium price. However, there is a limit to the premium which will be paid for anything regardless of the demand. When the price of any commodity becomes more than the purchaser is willing to pay, the demand begins to diminish, and engineering is finding itself in this position. Today's problems are more complicated than those of a few years back and, in general, the profession is doing a better job than it did fifteen years ago. Both conditions have contributed to the increased cost of engineering but they do not account for the over-all percentage increase during the past fifteen years. We have been prone to excuse engineering inefficiency by the increased difficulty of the problem and the better job we have been doing. But we should not lose sight of the fact that the cost of engineering in terms of percentage of the total cost of the finished plant or product has doubled, and even tripled in some instances.

In general, these points have been management-biased. This emphasis has been purposeful because our best method of improving our financial status is to appreciate the problems governing our present status, and to improve on those things which apparently are the limiting factors. This approach should, in time, obtain results satisfactory to all concerned.

Dan McQuaid, the cowboy engineer, as he classifies himself, has succeeded in equating this problem in true engineering fashion. Any position, engineering or otherwise, can be evaluated by the formula $V = A - S$, i.e., the value of any position is equal to the ability of the individual to produce, minus supervision. By transposing this equation and going back to our original definitions, we find our natural capacity or inventiveness, less the supervision required, establishes the value of the work we do. Increasing the productivity or quality of our engineering effort will result in greater reward.

[1] Based on three papers sponsored by the National Junior Committee and the Education Committee, and presented at the Fall Meeting, Denver, Colo., Sept. 10-12, 1956, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[2] By J. A. McCormack, Stearns-Roger Manufacturing Company, Denver, Colo.

A Statistical Analysis[3]

The Engineers Joint Council and the National Society of Professional Engineers each have information that is helpful in consideration of this question, and statistics are available from several other sources. It is important to keep in mind that the various methods used in collecting the data when gathered, the differences in the size of the samples, and other factors will affect a true comparison of the results.

Other Professional Salaries

The median income for several professions is shown in Table 1, while a 1951 survey of the U. S. Dept. of Commerce gave the median income of physicians as $10,528; dentists $6501; and lawyers $6956. A 1954 report of the American Bar Association reports average net income of all lawyers as $7532.

Table 1 Median Income in Selected Professions*

Accountants and auditors	$4022
Architects	5580
Chemists	4373
Dentists	6232
Engineers:	
Aeronautical	4851
Civil	4518
Electrical	4690
Mechanical	4633
Other	4834
Lawyers and judges	6257
Physicians and surgeons	8115
Surveyors	2805

* Source: 1950 Census, chart on "Professional Employment Statistics."

The American Chemical Society reported in a sampling survey of 1950 income, a median of $3800, five years after BS degree; $6800 after fifteen years; $8300 after twenty-five years; and $9000 after thirty-five years of experience.

A survey by the American Institute of Architects disclosed a 1949 median income for beginning member practitioners of $5400, rising to $14,000 at the age of 62.

Table 2 Engineers' Income by Age Groups*

35-39	$ 7300
40-44	8100
45-49	8700
50-54	9300
55-59	10000
60-64	10000
65-69	10200
70	9300

* Source: U. S. Dept. of Labor, Bureau of Labor Statistics, report on "Employment, Education, and Income of Engineers, 1949-50."

In Table 2, engineers' income is shown according to age groups.

In comparing these statistics it is important to remember the difference in employment practice in the different professions. Approximately 35 per cent of the lawyers, 22 per cent of all physicians, and 8 per cent of all dentists are engaged in major salary positions. The architects do not report how many of their men are on salary positions, but they do report that the salary range for private employees started at $5000 at age 28 and ran up to $8000 at age 53. This compares with the range from $5400 to $14,000 for architects in self-employment. Engineers who are self-employed in the consulting business show an income of $10,700 which is $2300 higher than those in private industry. Engineers who are self-employed as the owners of businesses report an income of $14,700. This is $6300 higher than the income received by engineers in private industry. This difference in salaries between persons in private employment and those employed by others exists in nearly all the learned professions.

Also, we must keep in mind the length and type of training required for each of the professions considered. The Council of Dental Education reports that 27 per cent of the men admitted to dental school have four years of college work and 42 per cent have a master's or other advanced degree.

The American Society of Mechanical Engineers, in 1954, conducted a survey of its members asking them to report their income and their age shown in Table 3.

Table 3 Mean Income of ASME Members, 1954

Age	Arith. Mean
24	4700
25-26	5400
27-28	6000
29-30	6600
31-32	7000
33-34	7700
35-39	9500
40-44	12100
45-49	14700
50-54	15100
55-65	15900
65	14900

The arithmetical mean of the whole report is $9500. To compare this report with any of the other figures just reported is difficult, because this is a select group and not necessarily representative of all the engineers in the country. This mean compares with an over-all median of $8100 taken from a 1949-1950 survey by eighteen engineering societies of members 35 years of age and over.

Engineers Joint Council in their 1953 report "Professional Income of Engineers" have gathered together information that is more current than other reports and presented in a manner that is of interest to all engineers. If you wish to study this problem further this book will be an excellent source of information. The book contains fifteen graphs showing the earnings of engineers in all branches of industry with the year of entry into the profession. The graphs not only show the median salary but the upper quartile and the lower quartile.

The information in the table showing the earnings of engineers in industry is worthy of consideration. This

[3] By Donald C. Neithercut, American Iron and Steel Works, Denver, Colo.

is a composite of all the other graphs and covers 295 salary reports of 65,169 engineers. The median salary reported by year of entry into the profession appears in Table 4. The upper and lower-quartile lines in this table begin close to the median and become more divergent as the length of service becomes longer.

Table 4 Salaries of Engineers in Industry by Year of Entry Into the Profession[a]

Year	Median
1952	$4284
51	4664
50	4822
49	5106
48	5382
47	5617
46	5582
45	5840
40-44	6593
35-39	7714
30-34	8043
25-29	8792
20-24	9158
15-19	9399
10-14	9126

[a] Source: Engineers Joint Council, 1953 report, "Professional Income of Engineers."

Engineering Salaries in Industry

A comparison of salaries by various industries will be helpful. The years 1940 to 1944 show the greatest number of engineers entering industry, and a comparison of salaries for this bracket only is shown in Table 5. The salaries given are median figures for the several industries reporting.

Table 5 Salaries of Engineers by Type of Industry[a]

Type of Industry	Median
Industry total	$6593
Chemical allied products	7195
Machinery manufacturing	6333
Electric machinery	6990
Transportation equipment	7446
Scientific instruments	7050
Metal, mining, and primary metal fabricators	6423
Extraction of crude oil and gas	6757
Miscellaneous services	7440
Other industries	6736
Civilian government	5827
Engineering education (teachers' salaries only)	4632
Engineering education (total income)	6148

[a] Source: EJC 1953 report.

The table shows a salary difference by industry, ranging from a high of $7440 in the transportation-equipment industry and also miscellaneous services to a low of $4632 for engineering educators. The median salary for all engineers in this report is $6593. The most disheartening fact to be revealed from this comparison is the low salary of engineering educators. Even working part time at jobs other than teaching, their total income did not come within $400 of the median for all engineers. Civilian government engineers, earning $5827, were over $700 lower than the median. Both of these brackets should receive our careful attention and thought. The salary differences shown in this age group are not an exception. A similar range of salaries would be shown for age groups other than the one discussed.

Ratio to Skilled Labor

Of all the reports and statistics read in the preparation of this paper none was so disturbing as the comparison of the growth of engineers salaries' with those of skilled labor. In 1939, professional engineers reported a median income for the newest engineers of $1590 increasing to $6017 for the men with 35 to 39 years' experience. By the year 1943 the newcomer's median had increased 60 per cent to a salary of $2564. The 35 to 39-years'-experience man had increased to $6564 or only 9 per cent. A 1953 report of EJC shows that the beginning salary of men entering the field in 1952 was $4284, an increase of 69 per cent over the 1939 figure and 67 per cent over the 1943 figure. The experienced man has realized a growth of salary to $9399, an increase of 56 per cent over 1939, and an increase of 43 per cent over 1943.

To appreciate how serious this situation is becoming, consider the criterion that a man's salary should be twice the existing starting wage when he has had 15 to 20 years' experience. This amounts to an annual salary increase of 4.7 per cent per year! A curve of starting rates from 1920 to 1953 shows an ever-increasing rate of pay from $1000 to the present of about $5000. A curve of double the starting rates after 15 years' experience, developed from the first curve, will show a rate of increase in pay that is astronomical. Such increases could not be given without seriously affecting the economy of the country. The problem cannot be dropped here even if the projected salary is beyond present standards, because the experienced engineer must be protected and the new engineer must be shown rates of salary increase that are in keeping with other professions. If we cannot do this we will not continue to attract the quantity and quality of men demanded by industry.

The new engineer, in 1940, received a salary that was 65 per cent of the pay of the skilled workers. The engineer with 15 years' experience in 1940 was receiving a salary 1.95 times the pay of skilled workers. In 1951 the 15-year man was getting only 1.25 times the pay of skilled workers while the one-year man was getting 0.70 times the pay of skilled workers. The one-year man had actually improved his relationship 7.6 per cent.

The engineer with 5 years' experience took the worst beating. In 1940 his relationship was 1.20 and by 1951 it had dropped to 0.94 or a loss of 21.6 per cent. This same engineer with five years' experience in 1940 is the man with 16 years' experience in 1951. If the increase in skilled workers' wages is about the same as the increase in cost of living, then this engineer has not increased his purchasing power in 11 years of labor. Engineers should take a careful look at this ever-narrowing gap between the wage scales of skilled and semiskilled workers and their own salaries.

Education and Compensation

Further education and training seem to be one way that engineers can promote themselves financially and

advance to jobs in their company with more prestige.

The figures in Table 6 show that engineers have the highest pay of all the sciences reported and at the same time the lowest percentage of PhD's in their respective fields. If the young engineer has the means of inclination toward further education he will be well repaid for the time spent in gaining this additional training. Many companies are encouraging their men to continue their training, with some companies paying all or part of the tuition costs.

Table 6 1948 Median Income of Scientists With PhD's, and Per Cent in the Field Possessing PhD[a]

	Median	Per Cent in Field
All fields	$7070	62.4
Chemistry	6880	78.4
Engineering	8000	33.3
Physics and electronics	7350	70.7
Earth sciences	7780	63.7
Agriculture	6670	55.9
Biology	6250	75.9
Fields related to medicine	6850	46.7
Mathematics and statistics	7350	83.2
Psychology	7940	93.8

[a] Source: U. S. Dept. of Labor, Bureau of Labor Statistics Bulletin, "Employment, Education, and Earnings of American Men of Science."

Management and its related functions also attract engineers. A survey of 900 top executives disclosed that 45.5 per cent had a major educational background in engineering and science. It has been further estimated that 60 per cent of all engineers are engaged in administrative work 20 years after graduation. One of the reasons that the engineers' top salaries level off in the older age brackets is that many of the outstanding men leave engineering and move to administrative positions. If you feel that this is the road you will follow, then you must develop the techniques and talents that make for a successful executive.

The professional development of the engineer who wishes to grow must not be neglected. If you are not registered, then you must take this important step. If you are registered, then you should use your seal and display your certificate. Belonging and participating in the activities of a national society will develop professional attitudes that will assist you to mature in the correct direction.

Personality development of the engineer who wishes to get ahead should not be neglected. A good personality is an asset that no one can afford not to develop.

Some Conclusions[4]

On the surface it would appear, based on annual income averages, that the legal and medical professions in most areas receive a greater compensation for equally important services than the engineering profession. Therefore, by this comparison, the engineer is generally underpaid. This situation should, of course, be tempered by local standards with some consideration given to the fact that part of each engineer's compensation is not received in the form of monetary reward but in the form of monumental accomplishment, personal satisfaction, and kindred community spirit.

Relation to National Economy

However, before a conclusion is reached in this regard, some important factors in connection with our national economy should be considered. "The true test of any system is the ability of that system to defend itself in the marketplace!" And upon this premise we must agree that as a nation we must have the benefit of a world market to absorb our full peacetime production, as we have not yet developed a successful system of economic perpetual motion. In order to have this market and maintain it, we must be competitive in the creation of engineering products. In a rather feeble attempt to meet this requirement we are currying a very dangerous practice. In many cases we are compromising quality for quantity, in a high-class game of "economic Russian roulette." We know our competitors have greatly increased their supply of technical personnel and production facilities in recent years. This has been done without noticeably raising their standard of living. These factors represent a rather serious situation and tell us that if we hope to maintain an economic balance in a highly competitive world market, we are going to have to put our own house in order. The solution to this impending problem seems to be opposed to the general premise of this paper, that engineers are underpaid. The following facts are offered for your consideration and study: For the past ten years we have experienced an ever-increasing spiral of inflation from which individuals have benefited less and less. As you know, labor costs have continued to rise, and material costs have continued to rise as a direct result, but as an end result, the cost of living has reached an all-time high.

Increasing Standard of Living

In many respects, we resemble the children of Babylon, building a tower far out in space whose proportions are exceeding the wildest imagination of its founders. As you well know, we have just witnessed the inception of another round of increases which will affect people at every level one way or another. In short, we are going to build our tower somewhat higher but we are not going to fortify its foundation with a stable national economy. As engineers, every one of you knows better than that. Our ever-increasing standard of living is very quietly pricing us out of a world market. This high standard of living amounts to a veneer of convenience to which we have become accustomed and which we have accepted as a necessity, but we must not continue to pursue the dictates of our personal wishes and desires while ignoring our national economy. With these exceptions we have established that, by and large, engineers are underpaid. We have also agreed that engineers' compensations are many and diversified.

[4] By Ralph Witherow, Stearns-Roger Manufacturing Company, Denver, Colo.

Briefing the Record

Abstracts and Comments Based on Current Periodicals and Events

J. J. Jaklitsch, Jr., *Editor*

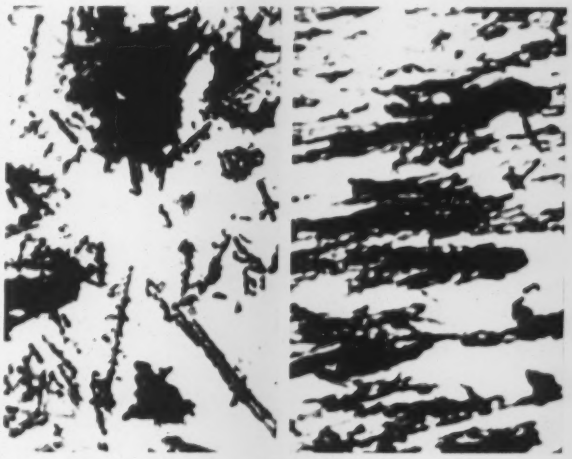
Superstrong Magnet

A REVOLUTIONARY and potentially superstrong magnet has been created with invisible iron "dust" by General Electric researchers.

Dr. T. O. Paine, of the company's Instrument Department at Lynn, Mass., told the American Association for the Advancement of Science that the unique properties of this magnet are achieved by precisely controlling the size and shape of individual iron particles so small that there are more than a billion billion in a pound.

Speaking at the annual Citation Dinner sponsored by the Industrial Science Section of the AAAS, held recently, in New York, N. Y., Dr. Paine said that, theoretically, the ultrafine particle iron magnet can be made ten times stronger than the best available magnets. Already experimental magnets have been made equal to the strongest commercial magnets, he added.

High light of the dinner was a citation, presented by Dr. A. T. Bonnell, section secretary, to E. E. Parker, Instrument Department general manager, calling the development "one of the major forward steps in industrial science in 1956." Dr. Bonnell is vice-president of Drexel Institute of Technology.



Iron "dust," used by General Electric to make a revolutionary permanent magnet, is shown as it appears under the powerful electron microscope, magnified 100,000 times. Each of the ultrafine, elongated iron particles is a separate magnet, so small that there are more than a billion billion in a pound. The new material derives potential superstrength and unique versatility from the researchers' ability to "break up" the magnetic log jam, *left*, and line up the minuscule iron particles, *right*, to achieve optimum strength.

Manipulating this compasslike torque tester, Dr. T. O. Paine records the characteristics of the new permanent magnet material announced by General Electric

"The new magnet," Mr. Parker said, "will result in electric instruments that are smaller, lighter, more accurate, and more rugged, making possible significant advances in instrumentation. It will help us make better photographic exposure meters, aircraft instruments, and other products using permanent magnets.

"This development opens whole new vistas to the design engineer because the iron particles can be embedded in plastics, metal, rubber, or glass. The magnets are easily machined, drilled, tapped, soldered, and molded precisely into any desired shape.

"Ordinary iron is used in the form of submicroscopic elongated particles to make the new magnet. This leads to another far-reaching benefit, the saving of strategic metals like nickel and cobalt—heavily used in making most magnets. Elimination of cobalt makes possible the application of magnets in nuclear reactors, where magnets containing cobalt cannot be used because of high induced radioactivity.

"Several years of close co-operation between scientists at the Instrument Department and the company's Re-

search Laboratory in Schenectady, N. Y.," said Mr. Parker, "gave us the research depth to 'break through' a scientific frontier that has been a world-wide goal for many years."

In his talk Dr. Paine said that the magnetic and mechanical properties of this material can be controlled precisely. Not only can the qualities of available magnets be duplicated, but we can achieve characteristics previously unattainable, he added.

As in the case of most new developments, said Dr. Paine, "the full impact can be measured only in retrospect." Meanwhile, he stated, work will continue toward the theoretical limit of magnetic energy.

The citation presented to General Electric by the AAAS is awarded to companies responsible for practical industrial application of basic scientific discoveries.

Iron Crystal Whiskers

One of modern science's oddities—highly pure and perfect metal crystals known as "whiskers"—are enabling scientists at the Westinghouse Research Laboratories in Pittsburgh, Pa., to gain new insight into the enormous forces which bind atoms together.

In a paper delivered during the recent New York meeting of the American Association for the Advancement of Science, Dr. R. L. Eisner, Westinghouse research physicist, described a new technique for evaluating these forces by measuring the tensile strength of whiskers of iron and silicon.

Dr. Eisner's technique is one of the most accurate methods known for pulling apart the tiny crystals and measuring directly the applied stress and the amount of strain they undergo. Precise, delicate equipment is required, Dr. Eisner said, because the tiny strands of metal may be 40 millionths of an inch or less in diameter—about one hundredth the thickness of a human hair. Use of the method has cast new light on the nature of the interatomic forces which give all metals their ultimate strength.

Interatomic forces in an iron crystal "whisker" are measured by stretching the tiny strand of metal. Forces of more than half a million pounds per square inch have been measured in a device developed by Dr. R. L. Eisner of the Westinghouse Research Laboratories.

"In whiskers, a metal exists in a perfect condition," Dr. Eisner said. "In contrast, any ordinary piece of metal contains countless millions of structural imperfections. Under stress, it is these imperfections which govern how and when the metal will break. They mask any attempt to measure the much larger forces which hold the metal atoms themselves together.

"By conducting tensile tests on whiskers, where these imperfections do not exist, we can pull the individual atoms far enough apart, without breaking, to get a measure of the interatomic forces. This enables us, for the first time, to check modern theories of interatomic forces."

In Dr. Eisner's whisker experiments, only a small force—less than one hundredth of an ounce—is required to pull the average whisker apart. This force, which must be controlled and measured with unusual accuracy, is obtained by a light-weight pendulum about 12 ft long. The whisker is "clamped" between the bob of the pendulum and a special "take-up" screw. As the screw is tightened, the whisker pulls the pendulum from its vertical position. Each millionth of an ounce of pull displaces the handling pendulum exactly the same amount—about 0.0001 in.

The stretch of the tiny whisker is measured by reflecting a beam of light from flat optical mirrors attached to the clamps at each end of the whisker, to form an "interference pattern." As the whisker stretches, the mirrors move and cause changes in the pattern similar to the changing "rainbow" colors seen in soap bubbles or thin films of oil. These changes are electronically amplified and analyzed to disclose the amount of stretch. The technique accurately measures changes in whisker length down to less than one millionth of an inch.

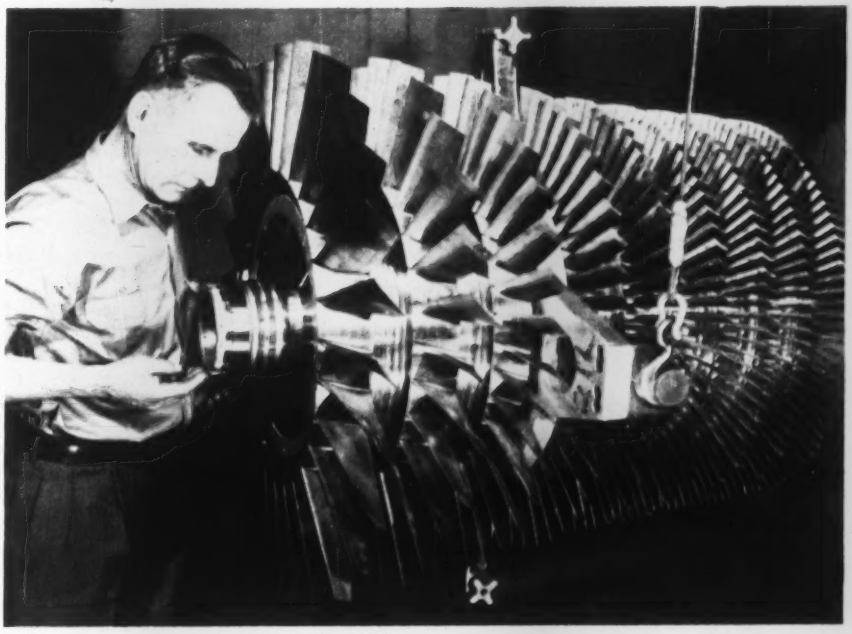
"Our experiments reveal considerable data about interatomic forces," Dr. Eisner said. "We have found that, freed of the limitation imposed by impurities and imperfections, these forces give iron a strength of more than half a million pounds per square inch.

"Whereas in ordinary steel the imperfections cause it to flow and deform at one-tenth its ultimate strength, we have found no such "plastic" deformation when interatomic forces only are involved. Even the elastic limit of 'soft' metals such as tin in the perfect structural state is at least ten times the maximum in the best steels in common use today.

"We think we are beginning to understand the origin of these interatomic forces which 'glue' atoms so tightly to one another. Our plan is to try our experiments on the very simplest metal atoms in order to gain additional data which, we hope, will verify our theoretical conclusions. Such an understanding, we feel, is a necessary first step toward some day making use of these enormous forces in the new and better metals of the future."

Titanium Industry Review

For the six-year-old titanium metal industry, the year 1956 was characterized by steeply declining price curves, record-shattering production volume, and very heavy capital equipment commitments to more than double production in 1957, according to T. W. Lippert, Manager of Sales and Technical Service, Titanium Metals Corporation of America. The industry also established new high levels of metallurgical quality, greatly expanded the recycling of mill scrap, and initiated production of heat-



This all-titanium J-57 compressor rotor is now in production at the Pratt & Whitney Aircraft Division of United Aircraft Corporation for advanced high-speed jet airplanes. Titanium blades, disks, as well as other titanium jet-engine components have shown outstanding performance under the severe test of flight operations.

treated alloy sheet of unprecedented strength, size, and gage uniformity.

Production of finished mill shapes, in 1956, totaled 10,600,000 lb which was about 25 per cent higher than the most optimistic first-of-the-year estimates. The mill products had an estimated market value of $130,000,000. The record year was particularly impressive in that there was a four to six-week interference in rolling operations caused by the mid-summer steel strike.

To support the 1956 production of 10,600,000 lb of finished mill products required output of about 23,000,000 lb of ingot metal. This, in turn, consumed some 20,000,000 lb of the pure basic raw material, titanium sponge. The difference of 3,000,000 lb represented the weight of alloy additions and recycling of titanium scrap.

Total sponge metal production, in 1956, jumped ahead to about 29,000,000 lb, some 9,000,000 lb more than was required to support finished metal shipments. This excess sponge, of about $28,000,000 estimated market value, was blotted up by in-plant inventory build-ups and some Governmental contractual purchasing.

Four melters and processors of titanium metal continued to dominate the market—Titanium Metals Corporation of America; Rem-Cru Titanium, Inc.; Mallory Sharon Titanium Corporation; and Republic Steel Corporation. Two newcomers started operations in 1956—Oregon Metallurgical Corporation at Albany, Ore., initiated an ingot melting facility; and Harvey Machine Company, Inc., Torrance, Calif., also started ingot furnaces to melt extrusion rounds. For the sponge metal, the major producer was Titanium Metals Corporation of America; others ranged in probable order of output were E. I. du Pont, Electro Metallurgical Company, Cramet, Inc., and Dow Chemical Company.

Sizable expansion plans were announced in 1956 by Titanium Metals Corporation of America and du Pont. The year's most significant regrouping of companies was the joining of Republic Steel Corporation and Cramet into an integrated operation, which was announced in June, 1956. Late in 1956 National Distillers Products Corporation announced plans for building a 5000-ton per year sponge plant at Ashtabula, Ohio, and Kennecott Copper Corporation and Allied Chemical and Dye Corporation announced the formation of a joint subsidiary to produce titanium metal. Also, of major significance was Titanium Metal Corporation's purchase, late in 1956, of a plant at Toronto, Ohio, which will be reconstructed as the industry's first facility for rolling and forging titanium exclusively on specially designed equipment.

The industry continued its dramatic downward price trend in 1956. Titanium Metals Corporation initiated an over-all 6 per cent reduction in mill-product prices on May 15 and followed with another 6 per cent reduction on December 3. On May 15 Titanium Metals dropped the sponge price 20 cents per lb to $3.25; on July 2 du Pont further reduced the price to $3; and on December 5 du Pont again reduced the price by 25¢ to $2.75 per lb.

The titanium producers have doubled and redoubled production in the past six years at a pace unparalleled in the metals industry. The firm goals set for 1957, however, represent a spectacular challenge of a 135 per cent increase. About 23,000,000 lb of mill products are scheduled for 1957 delivery, having an estimated value in excess of $200,000,000. Sponge production estimates for 1957 range between 50,000,000 lb and 56,000,000 lb, either quantity being quite adequate to take care of melting requirements.

Japanese imports of sponge into the United States totaled 3,500,000 lb during 1956, which was over three times 1955 shipments. It is expected that imports will step up to an even higher figure in 1957, as deliveries are made under a sizable barter agreement with the Commodity Credit Corporation.

The year was marked by growing interest in titanium usage for nonmilitary items, with the electronic and chemical-processing industries particularly active. In

military items, actual service performance is greatly exceeding expectations. Practically all advanced aircraft, jet engines, and guided missiles are employing large quantities of this strong, lightweight, and corrosion-resistant metal, particularly in those areas subject to high heat.

All commercial producers of titanium sponge continue to favor the use of either magnesium or sodium as reducing agents in the extractive process. As production mounts and know-how increases these conventional production methods are performing better and better, both cost-wise and quality-wise. The industry, however, continues its active search for a revolutionary new extractive procedure having possibilities of very low costs.

Titanium Head Shapes

THE widespread use of titanium was brought a step closer when the Lukens Steel Company announced recently that for the first time in history a "head of solid titanium was formed without the use of costly dies and stamping equipment."

Head shapes are used in a variety of industrial equipment to close up the ends of cylinders. Titanium, one of the most corrosion-resistant of all metals but still largely in the developmental stage, hitherto has been used chiefly in the aircraft industry.

But by forming a titanium head using highly versatile spinning equipment in the crucial stages, Lukens has broken a major cost barrier on the way to broadening the use of titanium, notably in the chemical and other process industries. Prior to Lukens announcement, titanium heads were made only with dies which had to be individually built for each variation in size and shape.

In a research program conducted jointly by Lukens and Rem-Cru Titanium, Inc., a Rem-Cru A-55 commercially pure titanium plate was placed on a spinning machine and worked at a minimum temperature of 600 F. The plate had previously been heated under close temperature control at 1400–1450 F. Then with standard equipment an elliptical-shaped head was spun 16 in. in diam and $^1/_4$ in. thick.

Initial tests were successfully completed at the company's Coatesville plant.

After further tests the titanium head will be shipped to Rem-Cru's plant in Midland, Pa., for further experimental work.

Turbine Overspeed Test Facility

CONSTRUCTION of a $2,500,000 "Overspeed Test Facility" has been started by General Electric Company's Large Steam Turbine-Generator Department.

The new test building will occupy some 8700 sq ft of space and will be used to spin steam-turbine rotors and generator rotors—which can weigh as much as 185 tons—at some 170 to 200 per cent above their normal speed of rotation. The test facility will be used to evaluate the effects of abnormally severe operations on the material properties and design features of the rotors during their performance.

In the center of the building will be a 57-ft-long, concrete cylindrical test chamber with an inside diameter of 16 ft. The walls of the cylinder will be constructed of 14 ft of reinforced concrete. An additional $1^1/_2$-in. steel-plate sleeve will line the inside of the cylinder.

A 5-ft-thick concrete wall will seal off one end of the overspeed test chamber, while a sliding steel door 4 in. thick will cover the entrance to the chamber when a unit is being tested.

The turbine or generator rotor to be tested will be placed inside the 16-ft-diam hollow section of the test chamber. The rotor will rest on bearing stands which are attached to a specially constructed type of railroad car which can be easily moved in and out of the chamber.

The rotor will be spun through breakaway couplings and gears attached to a 5000-hp turbine.

A 1500-hp braking turbine will be used for deceleration purposes. Steam at 380 psig at 710 F will be used to drive the turbines.

Turbine or generator rotors scheduled to be tested will be brought into the test facility on railroad cars, and a bridge crane will transfer the rotor to the test car.

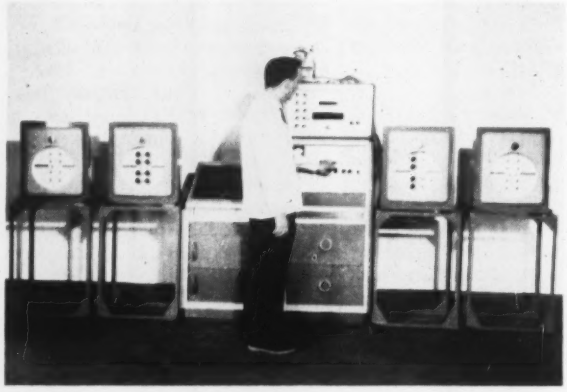
Operators of the test facility will be shielded during operations in one corner of the drive-turbine room by a concrete wall one foot thick. This is in addition to the 5-ft-thick concrete wall closing off the test cylinder from the drive-turbine room.

A closed-circuit television system will provide the operators with a view of the interior of the test cylinder during tests.

Steam-Generating Unit Analyzer

AN ELECTRONIC system designed to analyze the operation of a giant steam-generating unit in a few hours has been developed jointly by The Babcock & Wilcox Company and the Bailey Meter Company.

By means of "sensing" elements linked to analog scanners, the system can probe hundreds of different boiler locations. At the touch of a button, it begins



Basic components of Electronic system designed by The Babcock & Wilcox Company and the Bailey Meter Company to analyze operation of steam-generating boilers. Scanners, four units on steel frames, gather data from sensing elements located at different parts of boiler. "Digitizer," at operator's back, receives data from scanners, converts them from electrical values to digits. Upper cabinet, *center,* stores data and feeds them to perforator (*top*). Tape is then fed into teletype machine (not shown), which transmits data to computer at distant point. Lower cabinet in center is synchronizer, which directs operation of scanners and acts as control center for system.

gathering such data as temperature, pressure, and gas composition. Complex electronic devices, operating without human guidance, then sort the information, supplement it with preset figures, and punch it in code on continuous tape.

Tape Readings Fed to Computer

Tape readings are transmitted by teletype to New York City, where B&W has a large electronic computer. Translated automatically into code suitable for computer use, the information is processed mathematically and transmitted back to the boiler site for application by engineers and technicians.

The new system has been developed to help engineers determine quickly and economically such boiler problems as sources of heat losses, the most efficient types of fuels, and when and where to remove combustion waste deposits.

Emphasizing the need for a method of correcting material or operating faults promptly, B&W authorities pointed out that boiler malfunctions and abnormal fuel consumption may continue for weeks under ordinary trouble-shooting methods. They said that the system also represents an effort to conserve critically short engineering manpower by reducing the number of personnel and the amount of time required to conduct boiler analyses.

The "brain" of the system is a centrally located electronic co-ordinating unit developed at the B&W Research Center at Alliance, Ohio. A special "scanning" device created by the Bailey Meter Company of Cleveland, Ohio, makes it possible for the system to gather data from widespread points of a boiler. Each scanning unit collects information from 25 different sensing elements.

Any number of these devices may be hooked up with the system, depending on the quantity and location of points from which information is desired.

Recently the system underwent performance tests at the West Penn Power Company's Springdale, Pa., station, where it was used to gather data from 140 locations of boiler number 88.

Potentials of the new equipment will be more fully realized, B&W officials believe, when it is applied to the first of three steam-generating units of a new type being built by B&W on the American Gas and Electric Company power system. This unit, located at the Ohio Power Company's Philo plant, near Zanesville, Ohio, will utilize the highest steam pressure and temperature ever employed in the commercial production of electric power.

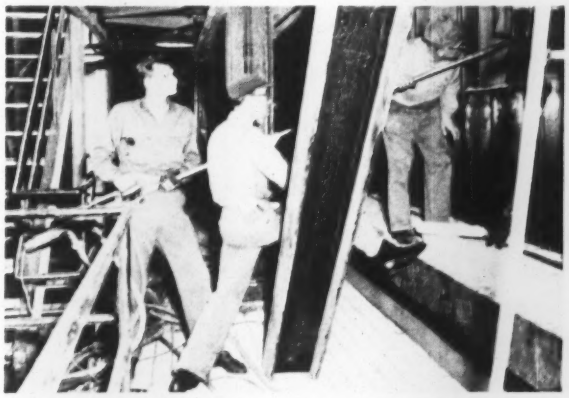
Data will be gathered from 500 different locations of the Philo unit, compared with 140 at Springdale. Successful operation of the system on this unit, B&W officials feel, will conserve both manpower and money during the boiler's "proving-out" stage, and provide performance data of a type that was unobtainable in the past.

Spokesmen for the Bailey Meter Company, which plans to make the new equipment available commercially if it proves successful, said that the system has been designed primarily for the analysis of large steam-generating units. They added, however, that it should be adaptable to smaller boilers or boiler elements, and capable of being moved readily from one boiler to another.

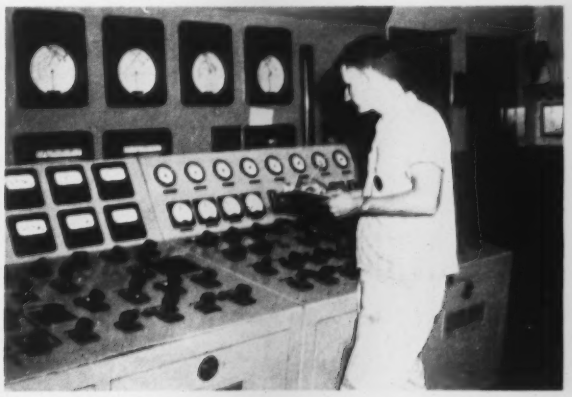
Future Tests

In future tests, officials of the two companies revealed, the system will be applied not only to boilers, but to a broad range of equipment used in conjunction with them.

They said that the system may shed new light, for example, on the combined operating efficiency of turbines and auxiliary equipment used to produce and distribute electric power.



This is one of manual data-gathering tasks which may be eliminated by new electronic system designed by Babcock & Wilcox and Bailey Meter Company to analyze steam-generating boiler operation automatically. Here, at West Penn Power Company's Springdale, Pa., station, B&W engineers use water-cooled probe to take gas temperature of boiler. Process must be repeated many times to obtain average reading. New electronic system is designed to arrive at same conclusions in a fraction of the time—and thereby release critically short technical manpower for other engineering work.



Laborious, expensive process of logging instrument readings manually is one of many tasks Babcock & Wilcox Company and Bailey Meter Company hope to eliminate with new electronic system they have developed to analyze steam-generating boiler operations electronically. This B&W engineer, working in boiler control room of West Penn Power Company's Springdale, Pa., station, must constantly check dozens of instruments and log their readings for five-hour stretch; processing these data for application to boiler takes additional days. New system is designed to gather data and process them in a few hours.

450,000-Kw Generating Unit

THE Philip Sporn Plant has been selected as the site for the second of two 450,000-kw electric-power-generating units—largest in the world, it was announced recently.

The Sporn Plant is on the American Gas and Electric Company System at Graham Station, W. Va., and now has a generating capacity of 600,000 kw. It is jointly owned and operated by Appalachian Electric Power Company and Ohio Power Company, AGE operating subsidiaries.

Like its AGE System sister unit, which is being built by Indiana & Michigan Electric Company on the Wabash River in Sullivan County, Ind., the new Sporn unit will be 73 per cent larger than any power-producing unit operating today.

Construction would be undertaken early this year and completion is scheduled for late 1959. Cost of the project has been estimated at $58,000,000.

With a capacity equivalent to more than 600,000 hp, the unit will be theoretically capable of supplying all the residential electric requirements of a city with a population of 4,000,000.

It will utilize close to 3,000,000 lb of steam per hr at the above-critical pressure of 3500 psi, a steam temperature of 1050 F, and it will consume 1,300,000 tons of coal yearly.

At present, Sporn Plant is the largest power station on the AGE System and the largest in West Virginia. It has four identical 150,000-kw units, the first of which was placed in operation in January, 1950, and the last in February, 1952.

Completion of the new unit will raise the plant's capability to 1,050,000 kw. At present, only two privately owned power plants in the world have capacities in excess of 1,000,000 kw. Like the Sporn Plant, they also are located on the Ohio River: the 1,290,000-kw Clifty Creek Plant at Madison, Ind., and the 1,075,000-kw Kyger Creek Plant at Cheshire, Ohio, a few miles downstream from the Sporn Plant.

The new Sporn unit and its sister unit on the Wabash represent the final 900,000 kw of new power production facilities in the AGE System's recently announced $700-million five-year expansion program. This expansion, extending from 1956 through 1960, will include the addition of 2,885,000 kw of new capacity and will raise the AGE System's total capacity to almost 7,000,000 kw by the end of 1960.

Upon their completion it is expected that both units will show an improvement of 5 per cent in thermal efficiency over the world's best unit to date, as well as a $7\frac{1}{2}$ per cent improvement in capital cost per kilowatt of generating capacity. The latter will be brought about by economies due to larger size of unit, higher turbine speed, space reduction, elimination of boiler house, and many other factors. While these units will be capable of producing twice as much electric power as the largest-sized unit now under construction on the AGE System—225,000 kw—the space they require is only approximately one-third larger.

General Electric Company will build the turbine-generator for both 450,000-kw units, which will be cross-compound in design. The Babcock & Wilcox Company will build each unit's 23-story boiler, which will be of outdoor design and will exhaust to a stack with a height of more than 500 ft.

Extending through nearly four miles of rural Texas area, this schedule 40 Alcoa aluminum pipeline was buried completely devoid of protective coatings and anodes. The pipe runs through soil ranging from sand and gumbo to salty marsh. Alcoa is counting on the high corrosion-resistance of aluminum pipe to deliver long, efficient, low-cost service.

Aluminum Gas-Carrying Pipeline

INSTALLATION of major aluminum, gas-carrying pipeline that resists corrosion without costly external protection was completed recently by Aluminum Company of America.

The big pipeline, 8 in. in diam and 20,000 ft long, ranks as the largest, longest unprotected aluminum gas transmission line now in service. It was installed by Lavaca Pipe Line Company as part of the gas transportation system servicing Alcoa's Point Comfort, Texas operations.

Extending through nearly four miles of rural area, the schedule 40 pipe is buried in soil ranging from sand and gumbo, to salty marsh. Completely devoid of protective coatings and anodes, the aluminum line is shielded only by electrical insulation at certain flanged joints. Anodes will be installed on test sections, however, to provide a detailed study of their effectiveness.

Alcoa is counting on the high corrosion-resistance of aluminum pipe to deliver long, efficient, low-cost service. Performance of the pipeline is expected to confirm dramatically the light metal's suitability for tough oil country use.

Normal procedure for steel pipe, buried under similar conditions, calls for a protective coating and complete swathing in wrapping material to guard against corrosion. Leading authorities also advise the use of cathodic protection as an additional barrier against external corrosion of steel pipe.

Elimination of these costly protective measures is expected to boost the already growing demand for aluminum in the petroleum industry.

Lavaca Pipe Line workers, installing the aluminum line, joined 40-ft lengths using the argon-shielded tungsten arc and consumable electrode welding methods. The aluminum pipe was extruded at Alcoa's Lafayette, Ind., works. Gas flows through the new aluminum line at a pressure just under 500 psi to help meet the mounting

To install the line, Lavaca Pipe Line workers joined 40-ft lengths of aluminum pipe using the argon-shielded tungsten arc and consumable electrode welding methods. The pipe was extruded at Alcoa's Lafayette, Ind., works. The 8-in-diam, 20,000-ft-long pipeline is the longest, largest, unprotected aluminum gas transmission line now in service.

fuel needs generated by the expansion program under way at Alcoa's Point Comfort operations. The line has been tested at 800 psi and has a calculated bursting pressure of 1500 psi.

Supersonic Safety Glass

Silicone rubber, since its development 12 years ago, has been the accepted material for frames, cushions, and seals around aircraft and other "extreme temperature room" windows. Now it's inside the window itself. Specifically, it serves as the center layer in "safety glass" windshields for supersonic aircraft.

The new silicone rubber, known as "Silastic Type K Interlayer," was developed by Dow Corning Corporation in conjunction with the Wright Air Development Center.

Development of Type K Interlayer goes back over 2 years—ever since it became evident that plasticized polyvinyl butyral, the conventional safety-glass interlayer, would not withstand the intense frictional heat generated by potential aircraft speeds.

Above 180 F, for example, the conventional interlayer softens, evolves gas bubbles, and rapidly loses shear strength. At the other end of the scale, temperatures in the range of −65 F render it almost as brittle as glass itself. At either extreme, conventional interlayer material is unable to prevent glass from shattering if cracked.

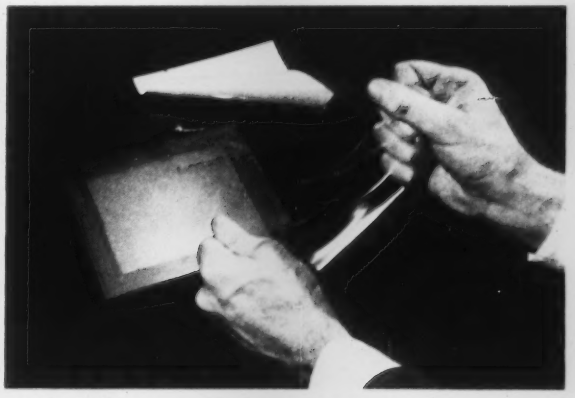
Laminated windshields made with Silastic Type K, on the other hand, retain full strength and clarity at temperatures ranging from −65 to over 350 F. At up to 160 F they have somewhat less shatter-resistance than the conventional laminate, but the strength of the conventional plastic interlayer falls off so sharply above 160 F that at 200 F the new silicone is more than twice as strong.

In the uncured stage, Type K is a soft, plastic, and extremely tacky sheet, calendered between layers of polyethylene-coated paper. Readily flowable under pressure, it requires no bonding adhesive. When laminated and cured under pressure in either flat or curved "glazings," it forms a tough rubbery interlayer with excellent optical properties. Haze and distortion are minimized, and a high order of transmittance is obtained over the entire spectrum. In a few words, the new rubber is truly transparent.

Availability at present is limited, but larger-scale manufacturing facilities are under construction at Dow Corning.

Lamination of the material within windshield glass is being done by Libby-Owens-Ford Company, Toledo, Ohio, and Pittsburgh Plate Glass Company, Pittsburgh, Pa., both of whom have developed techniques for laminating finished glazings.

After a few minutes at 375 F, the plastic interlayer in conventional safety glass, *left,* softens, bubbles, and oozes out the panel edges, robbing the laminate of shatter-resistance. Panels based on Silastic Type K Interlayer, *right,* however, remain clear and shatterproof even after hours at a temperature of 375 F.



Demonstration sample illustrates transparency, elasticity, and mechanical strength of Silastic Type K Interlayer for "supersonic safety glass." Ordinarily, the soft, tacky uncured stage, *left*—calendered between layers of polyethylene-coated Kraft paper—is simply laid between panes of glass and cured under heat and pressure to form a single, shatterproof panel.

Automatic Riveting Machine

An electronically tape-controlled riveting machine is automatically mass-producing 20-ft-long fuel-sealed wing segments at Northrop Aircraft, Inc., Hawthorne, Calif.

With the machine production has been increased 400 per cent through use of the automatic riveter. It requires only one operator, who stands by, push button in hand, to start and stop the machine when necessary.

The machine permits fuel-sealed slug rivets to be driven automatically without using soft metal sleeves or fuel sealant compounds. This was made possible by application of detail tools and techniques developed at Northrop to a Drivmatic Riveter (Model G-39 ACV) manufactured by General Riveters, Inc., Buffalo, N. Y.

Setup of the complex device is accomplished by sighting in a "master part" with a transit or sight level. Each rivet hole is thus located to pinpoint accuracy, and the machine's three tapes are then punched with data corresponding to the positioning and cycling requirements according to indicators located at the edge of the tape. The holes are punched in opaque 35-mm film (du Pont Kronar film). They allow a small bright light to activate photoelectric cells beneath the tapes.

"Black boxes" on either end of the machine's carriage each contain a tape to control transverse travel of the part. A large black box contains a tape to control longitudinal travel of the carriage and to actuate the automatic riveting sequences.

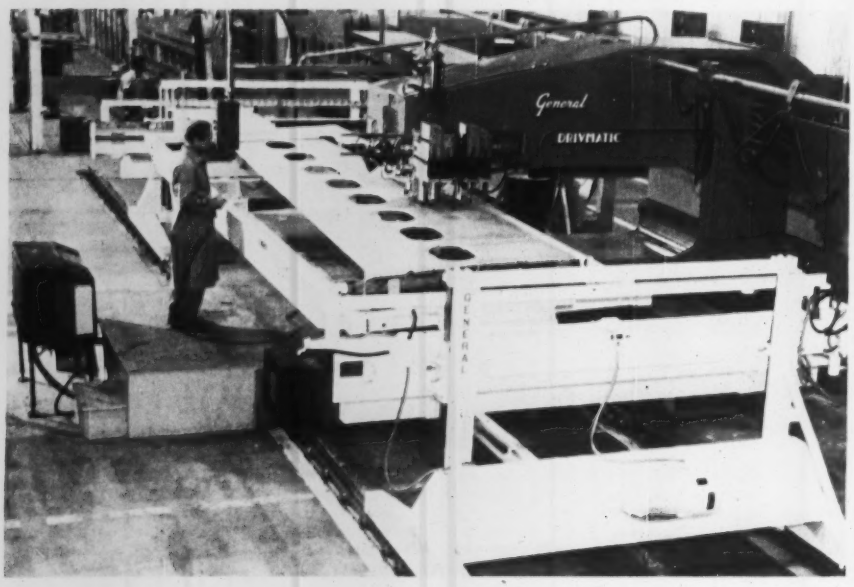
On the latter tape as many as seven rows of holes, each controlling a different operation, may be punched across the tape.

The electronic eye, which controls location of the drilling head over the rivet location, is flanked on either side by sensing eyes which shut off rapid transverse in anticipation of the inertia of the three-ton carriage when the punched hole passes over the sensing device. Thus the holes are drilled accurately at the proper location.

Other punched holes then carry on the following operations: The drilling head drills, reams, countersinks, and counterbores in one pass with a single tool. The slug rivets are automatically fed into a rivet injector, which in turn places the rivet in "rivet fingers" for transfer into the hole under the top rivet set. The top rivet gun set then bottoms the rivet on an opposing rivet set which has moved automatically to the proper depth beneath the rivet hole. Other punched holes automatically lower the bottom rivet set to clear projections such as ribs or stiffeners as the table travels and raise it again to its proper location.

Rivets are driven from the bottom at 16,000-lb pressure. The rivet is then shaved flush with the skin. No feather edge is left by the shaver due to the slight counterbore (0.010 in.) made in the countersink.

A pattern of holes punched in a reel of 35-mm film controls Northrop's huge automatic riveter. The machine mass-produces wing sections up to 20 ft in length at a 400 per cent increase in efficiency over former hand-riveting methods. The fully automatic machine requires only one operator.



Push-button mass production is now being accomplished at Northrop Aircraft, Inc., through use of this Drivmatic riveter. The machine automatically drives fuel-tight slug rivets in a wing section at the rate of seven rivets per minute. No further riveting work need be done to the component shown when the machine has completed its work. The part shown is an outer section of a wing segment which can hold fuel without further treatment. It is the first time nonjacketed fuel-tight rivets have been automatically riveted.

The curved part is kept horizontal at the drilling and riveting heads by twin cams which elevate and tilt the part to the proper attitude as the carriage travels.

Three types of drive are used on the machine. Longitudinal travel is governed by a hydraulic system built by Vickers, Inc., Detroit, Mich. Transverse travel is powered by two reversible piston-type Keller motors (Keller Air Tools Company, Chicago, Ill.). Up-and-down motion is caused by drive screws driven by geared electric motors (Century Electric Company, Los Angeles, Calif.).

The machine bed travels on a specially machined narrow-gage railway track 60 ft long. It is capable of handling all operations on seven rivets per minute. The type of work now being handled by Northrop formerly required five men per component.

Two men can set up the machine for an indefinite run, and a single operator makes four parts in the same period of time formerly required.

240-In-Stroke Broaching Machine

DEVELOPMENT of a new 240-in-stroke electromechanical drive broaching machine, that puts broaching in the giant class of machine tools, has been announced by The Lapointe Machine Tool Company of Hudson, Mass.

The 50-ft machine broaches the "pine tree" holding slots in the periphery of the gas-turbine wheels of the new 16,500-kw gas-turbine engine—the same type that was developed by General Electric Company to increase the speed of the World War II Liberty Ship by over 10 knots.

This machine broaches a slot 1.6 in. deep and up to 5 in. rim thickness, removing 150 lb of metal per wheel. The actual broaching time per wheel is $2^1/_3$ hr—this refers to the wheel with the big form, having 90 slots.

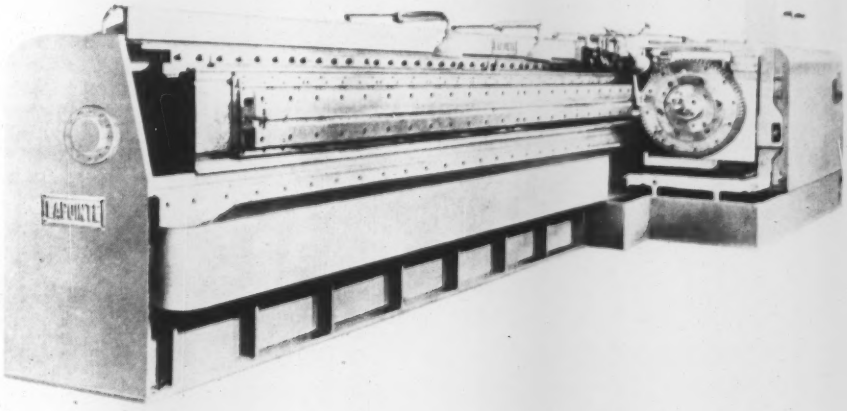
The slot is broached in two passes. The length of the broach cutting-section totals 450 in.

By changing broaching tools and using adapter plates on the indexing fixture, each turbine and compressor wheel can be broached on the same machine.

The variation in diameter of the wheel broached on the Lapointe indexing fixture is from 40 to 80 in., and the number of slots goes from 30 to 150. Index is held 0.0002 in. of true position. The broached form is held to within a tolerance of 0.0003 in. Lapointe high-speed steel broaches are used to cut the 422 stainless material in the turbine wheels.

The machine is of steel weldment construction and weighs 150,000 lb.

An adjustable voltage 100-hp broach drive equipment drives a 16,000-lb slide to assure smooth cutting action, increased tool life, and superior finish.



Lapointe single-ram horizontal electromechanical 240-in-stroke broaching machine, broaching "pine tree" slots in an 80-in. gas-turbine wheel

Boiling-Water Reactor Program

THE Atomic Energy Commission will construct and operate an experimental reactor facility which will be used to supplement current work in the boiling-water reactor program. It will be located at the National Reactor Testing Station in Idaho.

The experimental facility will consist of a reactor core and pressure vessel, steam condensers, heat exchangers, pumps, and the necessary valves, controls, and auxiliary equipment. It will have sufficient flexibility in size, power-removal equipment, and design pressure to simulate experimentally a wide range of operating conditions pertinent to the performance of boiling-water reactors.

The facility, to be known as the Argonne Boiling Reactor Facility (ARBOR), will be operated by the Argonne National Laboratory, Lemont, Ill., as an extension of the work on boiling water reactors currently being conducted by the laboratory. This work includes the so-called BORAX (Boiling Reactor) experiments and fabrication and operation of the Experimental Boiling Water Reactor.

The Argonne National Laboratory will be responsible for the conceptual design of the reactor and the detailed design of the reactor core, controls, and instrumentation. An architect-engineer, to be selected later, will design the reactor building and other features of the reactor system.

It is expected that experiments conducted at the new facility will contribute materially to the progress of

design studies now under way of several large central station power plants utilizing boiling-water reactors.

The cost of the facility is estimated to be $8,500,000 and it is expected to be in operation in late 1959.

Nuclear Fuel

Scientists of the General Electric Company have been assigned the task of investigating a possible new fuel for atomic power plants.

The research program is aimed at enriching natural uranium with plutonium as a fuel for power reactors.

The development work will be carried on at the Hanford plant which General Electric operates for the Atomic Energy Commission.

A fund of $700,000 in fiscal 1957 has been earmarked for early phases of the program, which is expected to have far-reaching significance in the nation's power picture.

The program is aimed at developing practical, low-cost methods of fabricating plutonium fuel elements, testing such elements in a small reactor, and subsequent reprocessing.

The goal set for General Electric in this research task is to make possible the use of plutonium to enrich natural uranium for power reactor fuels. The present U. S. reactor program is largely dependent on U-235 (enriched uranium), and on the complex gaseous diffusion process that produces the enriched uranium. The new fuel would eliminate the requirement that many countries either build only reactors designed to operate on natural uranium or commit themselves to importing enriched uranium. The new fuel also may make it possible to net more power from a given supply of uranium.

The decision to go ahead with the program was based on a study made by General Electric at the request of the AEC. The company will perform the research, development, and operation work for Hanford's plutonium recycle program under its present contract with the AEC.

Rail Conditioning

Development of a new method to greatly reduce slipping locomotive wheels on the rails, a long-standing problem of railroads, was announced jointly by the Reading Railroad, General Electric Company, and National Aluminate Corporation.

The results of nearly a decade of research and testing disclosed a way of spraying a new chemical on rails to improve traction.

Applied directly to the rails by a motorized car, operated independently of trains, the new chemical has shown under tests that it will give a minimum increase of 25 per cent in adhesion limits of locomotives over tonnage rating. The chemical will improve adhesion under all weather conditions.

The new process is known as "rail conditioning." It stemmed from exhaustive studies which revealed that an "almost invisible oil film spread by moisture and resisting the weight of locomotives was making rail slippery."

This discovery was the joint effort of engineers of General Electric and the Reading. After this was established, National Aluminate Corporation developed the new chemical which "broke the oil film" and produced an immediate improvement.

Tests of the new chemical were made over a period of years on the Reading's Catawissa Branch, in a mountainous area of North Central Pennsylvania, which has difficult grades for heavy tonnage trains. The tests are continuing on the Catawissa Branch.

While the tests disclosed a minimum rise of 25 per cent in adhesion with the chemical application to the rails, even greater increases result from grades less severe, shorter in length, or heavier in traffic volume. The results of the testing will be shared with other railroads.

Blueprints Reproduced Photographically

In addition to the obvious saving of space for storage, microfilming of blueprints would offer an inexpensive way of reproducing faded, torn, or soiled drawings if it were not for the critical nature of the measurements.

Experiments with 35-mm and 70-mm film have been unsuccessful because of the difficulty of controlling shrinkage of the film and the distortion involved. Keuffel & Esser Company of Hoboken, N. J., in association with Micro-Master, Inc., of Kansas City, Mo., has developed a system under the Micro-Master trade name using 105-mm roll-film negative. Film of this size is 16 times larger in area than 35-mm and permits distortion-free "second originals" up to 36 × 54 in. in size.

The rolls can be cut into 4 × 6-in. negatives, and as many as 450 of them can be stored in a single 6 × 9 × 12-in. file drawer, or less than 1 sq ft of space. By comparison, only a few dozen full-size drawings can be stored in one drawer of about 12 sq ft in area. Both the film and file envelopes conform to U. S. Bureau of Standards requirements for archival quality and will last a full century without loss of detail or clarity.

Blueprint storage problems are most acute in the aircraft industry. Lockheed's Super Constellation transport, alone, required 30,000 separate prints occupying 392 sq ft of storage, compared with 15 sq ft for the films.

The Micro-Master system for blueprint storage and reproduction includes a series of engineered projectors. The translucent drafting table shown permits adaptation of drawings by selective tracing of lines needed for a new drawing. Other projectors are for direct viewing, visual aids use, or photographic enlarging.

Micro-Master 105-mm negatives are exposed in rolls, then are examined for quality with a magnifying glass before being cut apart. Individual negatives, when separated, are first protected with a transparent sleeve, then are put into a Kraft envelope that meets archival standards. This new 105-mm reproduction system was developed by Micro-Master, Inc., in association with Keuffel & Esser.

To permit the maximum use of these negatives, a translucent-screen drafting table supplements the projection equipment for enlargements on opaque materials, and a table viewer permits reference to the drawings without printing or enlarging them. Mailing costs for the negatives are much lower than those for blueprints, and offset plates for quantity reproduction can be made directly from the negatives.

The equipment will not be sold for the present, but filming will be offered as a nationwide service. Within a few months, Micro-Master laboratories will be available in 40 major cities of the United States and Canada.

"Hot Material" Conveyer Belt

WHAT is believed to be the world's longest "hot material" conveyer belt has been delivered by the Goodyear Tire & Rubber Company to Erie Mining Company's new taconite pelletizing plant at Hoyt Lakes, Minn., located at the eastern end of the Mesabi Iron Range.

The highest-capacity belt of its type ever built by this company, it will haul hot taconite pellets with temperatures up to 250 F at a rate of more than 2000 tons per hr. Operating on a trailing conveyer 1400 ft long that rides on rails, the belt will feed the world's largest traveling belt conveyer stacker.

Being erected by the Link-Belt Company at Hoyt Lakes, the huge stacker and its trailing belt conveyer will be capable of building stockpiles 90 ft high, storing more than 4,000,000 tons of pellets in an area 800 ft wide at the base and 1300 ft long.

Goodyear's record hot belt is 42 in. wide and construction is of extra heavy rayon fabric in six plies with a special rubber compound forming belt covers.

A 300-hp drive motor will move material on the belt 525 fpm. Stockpiling at the pelletizing plant will be done mostly during the five winter months when navigation on the Great Lakes is closed.

Experimental Radar Station

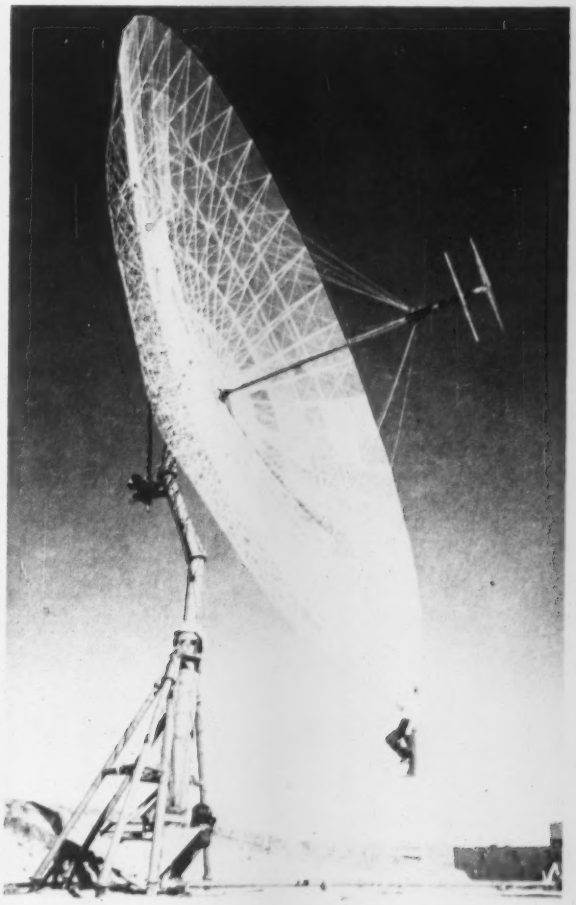
STANFORD Research Institute, Menlo Park, Calif., has transformed one of the rolling hills west of Palo Alto into an experimental radar station with installation of a giant 61-ft-diam antenna and 100-megacycle transmitter.

The equipment is being used by SRI's Engineering Division to gather data about the reflection from meteor and auroral ionization of very high frequency and ultra-high frequency radio signals.

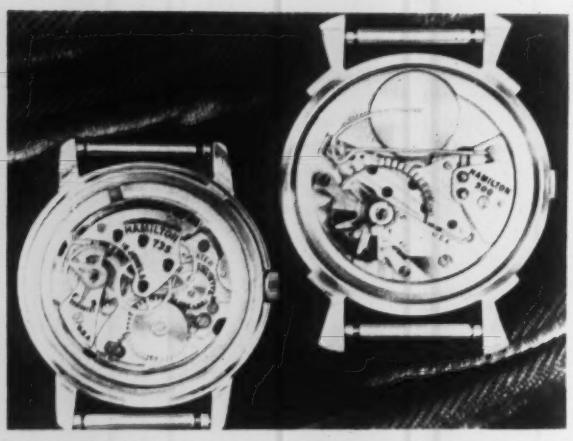
Meanwhile, an SRI team has been assigned to install and operate a similar radar unit at College, Alaska. The northern station is part of an associated program being carried out in conjunction with the Geophysical Institute, University of Alaska.

The Alaska installation will have a klystron transmitter in the 200-400 megacycle range and a 61-ft-diam parabolic antenna. The SRI research team will be in Alaska until the spring this year observing the scattering of radio signals by meter trails in the frequency range exceeding 100 megacycles.

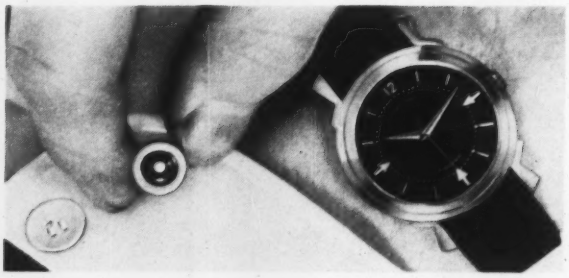
Sponsoring the two-phase program is the Rome Air Development Center, Air Research and Development Command, Griffiss Air Force Base, N. Y.



Stanford Research Institute's experimental radar station installation at Palo Alto, Calif.

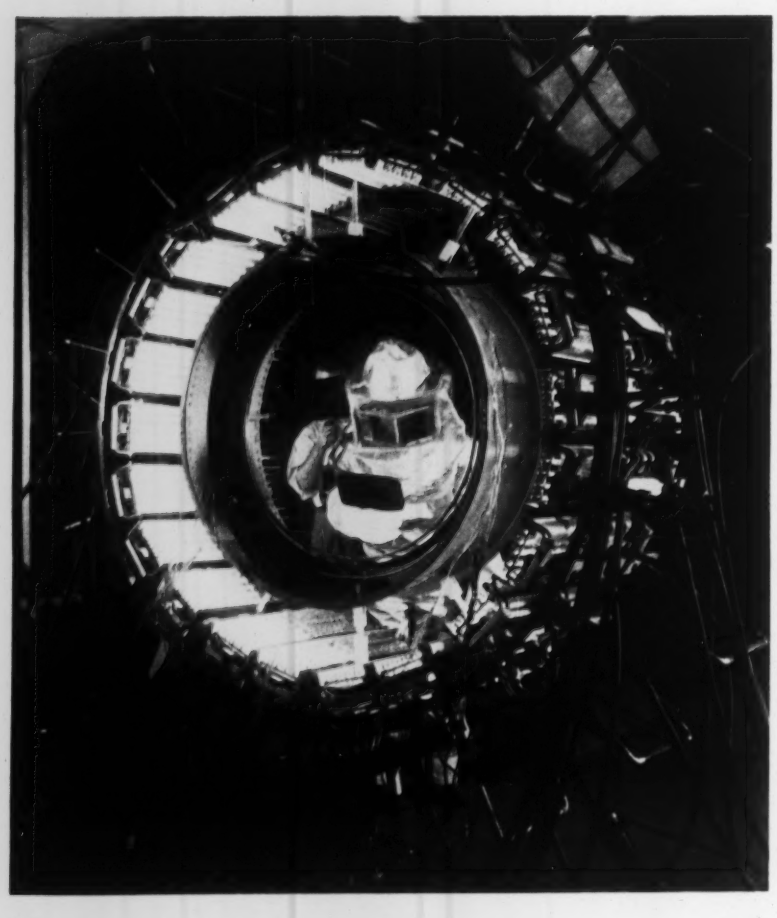


Electric Wrist Watch. Movement of the world's first electric wrist watch, *right*, is shown with movement of manually wound watch. Created by the Hamilton Watch Company, the electric watch has one third fewer parts and requires no winding or agitation. Large circle in top center of electric watch is energizer which replaces the mainspring. The energizer will run the watch for more than one year at an accuracy greater than 99.995 per cent.



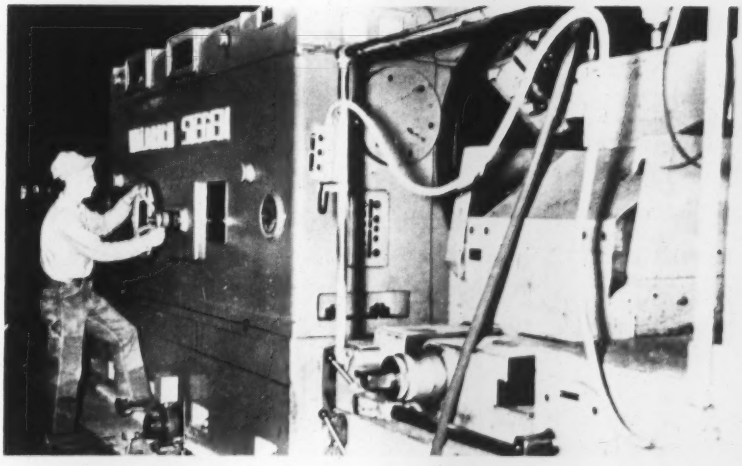
Hamilton's electric watch operates on chemical energy stored in this tiny energizer. This energy is converted into electrical power as it releases a stream of electrons through a coil of fine wire fixed on a balance wheel. The electrical energy through interaction with permanent magnetic fields causes the balance wheel to oscillate. This oscillation is the mechanical energy which runs the watch.

Photo Briefs



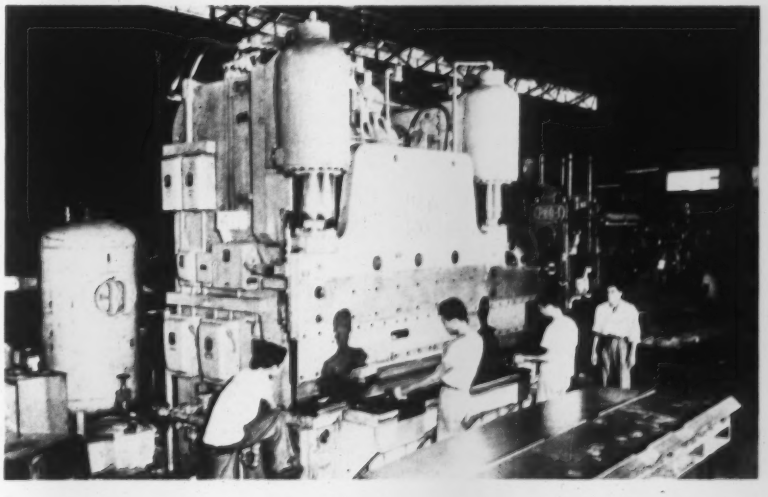
Heat-Problem Studies. Probing the thermal barrier in the Structures Test Laboratory of North American Aviation's Los Angeles Division, two engineers study the triple-torture effects of simultaneously heating and cooling a metal ring simulating a portion of an aircraft's fuselage while subjecting it to stress. The outside of the ring is heated to about 450 F by the battery of infrared lamps that encircle it, while the inside is cooled to 90 F by cold air blown through perforated aluminum tubes. At the same time, hydraulic devices pull at the metal to simulate stresses that might be encountered in flight. Through the maze of tubes and wires runs power for the lamps, air for cooling, and electronic impulses that automatically report strain and temperature data to a battery of recording devices. It takes a man a week or more to evaluate data recorded in the few minutes of one of these tests, which are part of North American's investigation of the heat problems created by the speed of today's—and tomorrow's—aircraft and missiles.

Earth Satellite. Dr. John P. Hagen, Director of Project Vanguard, is shown here with a full-scale cutaway model of the earth satellite designed by scientists working under his direction at the Naval Research Laboratory, Washington, D. C. The instrumentation shown inside includes telemetering equipment which will transmit a radio signal to earth after the satellite has been launched into space. This information, relayed to an IBM 704 electronic computer in Washington, D. C., will be used to predict and calculate the satellite's orbit. Scientists will try to place the satellite in an orbit from 200 to 300 miles above the earth sometime during the International Geophysical Year (IGY) which begins July 1, 1957, and continues through Dec. 31, 1958.



Double-Carriage Lathe. Operator at speed selector wheel here has no problem in getting response needed from this giant 250-hp double-carriage, German-made lathe, which with aid of Carboloy grade 370 carbide cutting tools does work of four lathes previously used by Ohio Foundry Company, Lima, Ohio. The lathe handles 31 to 60-ton rolls, enabling cutting tools to remove as much as 24,000 cu in. of steel in $2^{1}/_{2}$ hr — or about 8 tons in about 16 hr it takes to shape a roll.

Hydraulic Press Brake. This new hydraulic press brake permits the Ismael Steel Company in the Philippine Islands to combine mass production of electric refrigerators and fabrication of bridge members and other heavy steel structures on a single machine. The 500-ton press brake is set up with progressive dies so that a complete refrigerator door may be blanked, deep drawn, and formed at the rate of one door every minute. The dies and upper platen then may be removed and the brake used for forming, punching, straightening, and even shearing heavy plates for typical structural steel fabricating. The press brake is manufactured by Pacific Industrial Manufacturing Company, Oakland, Calif.



European Survey

Engineering Progress in the British Isles and Western Europe

J. Foster Petree,[1] Mem. ASME, *European Correspondent*

Tercentenary of the Pendulum Clock

GALILEO, and also Leonardo da Vinci, proposed to apply the pendulum to the control of clocks, but the credit for having actually done so is accepted as belonging to the Dutch physicist and mathematician, Christian Huygens (1629–1695), who made his first pendulum clock in December, 1656. He published his design in a book entitled "Horologium" in 1658. To mark the 300th anniversay of this noteworthy invention, the Science Museum in London, England, has organized a special exhibition, which was opened by the Netherlands Ambassador, His Excellency Dr. D. V. Stikker; it will remain open until February 24. Huygens' invention has been justifiably described as "the greatest step forward in the history of time measurement since the invention of the mechanical clock." Moreover, his realization that, to be truly isochronous, the pendulum must not describe an arc of a circle but some other curve, led him to develop a complete theory of the evolutes and involutes of curves, thereby making an important contribution to mathematics. The exhibition contains examples of the earliest pendulum clocks made in Holland, Belgium, England, France, and Germany, together with many drawings and photographs, which have been assembled together with the aid of a number of Continental museums and of the Antiquarian Horological Society of London.

Heavy-Duty Radial Boring Machine

A NEW design of radial boring machine for very heavy duty has been produced by William Asquith, Limited, of Halifax, Yorkshire, England, to drill up to 5-in-diam holes in mild steel or 6-in-diam holes in cast iron. It is made in five sizes, to work at maximum radii of 8 ft, 9 ft, 10 ft, 11 ft, and 12 ft from the center of the column. The machine illustrated is the 10-ft size. The spindle is driven by a 30-hp motor, carried on top of the slide, and, on the standard machines, has 24 speeds and nine feeds. A choice of three ranges of spindle speeds is available, from 750 down to 8 rpm, 450 to 5 rpm or 230 to 3 rpm, and the feeds range from 0.002 to 0.04 in. per revolution. For tapping, change wheels can be provided to cover all requirements from 4 to 40 threads per in. for English threads and 0.5 to 5-mm pitch for metric threads. Boring can be carried out, with a piloted bar from 20 to 30-in. diam, according to the speed range and the material. The spindle runs on precision preloaded ball and roller bearings, lubricated by oil mist. The start, stop, and reverse motions of the spindle are controlled by a single lever, operating friction clutches, which are designed to work with partial engagement for "inching" of the spindle rotation. The reverse speeds are 40 per cent faster than the forward speeds. Control of the arm elevating motion is by push button. The 24 mechanical changes of speed are controlled by two levers, moving in a gate on the left-hand side of the slide. Direct-reading speed-index plates show the lever positions for the different speeds. A rapid power traverse of the slide along the arm can be supplied as an extra. The elevating motor is of 35 hp in the three smallest sizes of the machine, and 40 hp for the 11-ft and 12-ft models. When the machine is supplied to work on the 230–233-rpm range of spindle speeds, a 20-hp driving motor is fitted instead of the 30 hp required for the higher speed ranges. The working surface of the baseplate, in the case of the machine illustrated, is 8 ft $9^1/_4$ in. × 6 ft. For the smallest size it is 6 ft 8 in. × 5 ft 6 in., and for the largest, 10 ft $6^1/_2$ in. × 6 ft 9 in.

The 10-ft size of the new heavy-duty radial boring machine, one of the five which work at maximum radii from 8 to 12 ft

[1] Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.

Atomic Power in the U. K.

THE world's first large-scale nuclear power station, at Calder Hall, Cumberland, England, which was put on load by Queen Elizabeth II on October 17, 1956, contains four turbogenerator sets, each of 21-mw capacity. It has now been announced that the Central Electricity Authority, the agency which owns and operates the power stations in England and Wales, has placed orders for two nuclear power stations and is negotiating for a third; they will aggregate some 850,000 kw and together will cost about £120 million (about 355 million dollars). In addition, the South of Scotland Electricity Board has decided to erect a fourth station. The two English stations will be at Bradwell, Essex, and Berkeley, Gloucestershire, and will have outputs of 300 mw and 275 mw, respectively. At Bradwell, the plant will consist of two natural-uranium graphite-moderated reactors, cooled by CO_2 gas and supplying heat to 12 boiler units. The steam from the boilers will be at two pressures, 755 psi and 195 psi both at the same temperature of 704 F, and will drive six dual-pressure turbogenerators of 52-mw capacity, running at 3000 rpm. The hydrogen-cooled alternators will be of standard type, generating at 11.8 kv. They will feed into generator transformers with a ratio of 11.8/132 kv and will be switched at 132 kv.

Each reactor core will comprise a vertical cylinder about 45 ft in diam and 31 ft high, built up from graphite blocks and containing about 2600 fuel channels, and will be enclosed in a spherical steel pressure vessel 67 ft in diam, with walls 3 in. thick. The reactor will be surrounded by a biological shield of concrete, 8 ft thick. The fuel elements will be rods of uranium, slightly more than an inch in diam, sheathed in magnesium alloy. CO_2 gas at a pressure of 130 psi will transfer the heat of reaction to the boiler units through ducts 5 ft in diam. On each boiler outlet there will be a variable-speed axial-flow blower to return the gas to the reactor vessel. These blowers will be driven by a-c induction motors, taking current from three 20-mw variable-speed turbogenerators (two working and one standby).

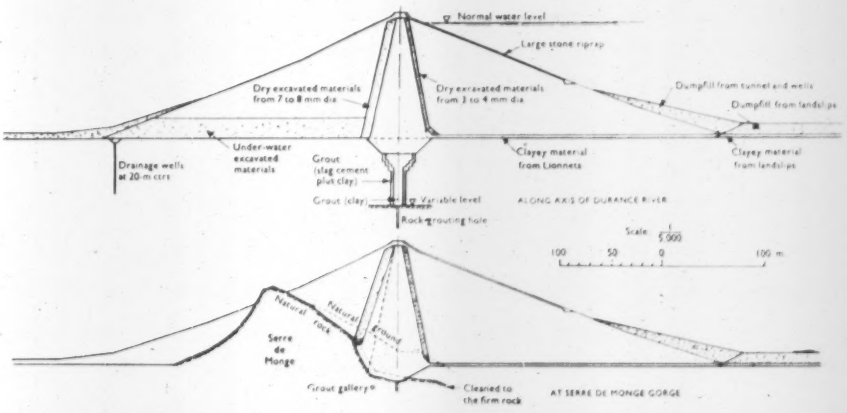
The Berkeley station will be similar in general design, but different in many of its details. The reactor cores will be 48 ft in diam and 30 ft high, with about 3000 fuel channels, but in this case they will be contained in cylindrical steel pressure vessels, 50 ft in diam and 80 ft high. The CO_2 gas will be circulated at 125 psi and each reactor will supply heat to eight boilers, or 16 in all, four to each of the four 80-mw turbogenerators. As at Bradwell, the steam will be generated at two pressures, 306 psi and 62 psi, both at 612 F. The boilers will be cylindrical steel shells about 70 ft high and 17 ft 6 in. in diam. The fuel for the reactors will be the same as at Bradwell. They will be refueled on load, a small number of channels being replenished almost daily.

The irradiated rods removed from the reactors will be stored for several months on site in a cooling pond, from which they will be collected at intervals by the United Kingdom Atomic Energy Authority and taken to one of their chemical factories, where the plutonium and fission products will be extracted. The Central Electricity Authority estimates that the capital cost will be $2\frac{1}{2}$ to 3 times that of a comparable station burning coal or oil. It is expected, however, that the construction costs of future nuclear power stations will be steadily reduced.

The Serre Poncon Dam

THE development of hydroelectric power has gone ahead rapidly in France since the war, but the principal projects have been for power purposes primarily. The work now in hand on the Durance River, a tributary of the Rhone, into which it flows above Avignon, has three objectives, however—the regulation of the river, which has a torrential regime; the irrigation of a large area of Provence which is now arid; and the eventual generation of some 10,000 million kwhr of electricity. A paper describing how this is to be done and giving details of the construction of the Serre Ponçon Dam (the largest of the three included in the complete project) was delivered in December by M. Raymond Giguet of Electricité de France, at a joint meeting of the Institution of Civil Engineers, London, and the Société des Ingénieurs Civils de France. The initial scheme, he stated, provided for a concrete dam, but later it was decided to build an earth dam, nearly 400 ft high, with a watertight core of slag cement and clay. The width of the dam at the base will be 2500 ft and it will contain more than 18,000,000 cu yd of material, of which 2,600,000 cu yd will represent the core.

The surface area of the reservoir that is to be formed will be approximately 11 square miles, but the capacity will be some 1530 million cu yd, which is more than twice that of the largest existing water-storage reservoir in France, that at Bort. The power station will be placed underground and will contain four vertical water-turbine sets, to develop a total of 360,000 kva, working on a gross head of 420 ft.


Normal water level
Large stone riprap
Dry excavated materials from 7 to 8 mm dia
Dry excavated materials from 3 to 4 mm dia
Dumpfill from tunnel and wells
Dumpfill from landslips
Drainage wells at 20-m centers
Under-water excavated materials
Grout (slag cement plus clay)
Clayey material from Lionnets
Clayey material from landslips
Grout (clay)
Variable level
Rock-grouting hole
ALONG AXIS OF DURANCE RIVER
Scale 1/5000
100 50 0 100 m
Natural rock ground
Serre de Monge
Grout gallery
Cleaned to the firm rock
AT SERRE DE MONGE GORGE

Cross section of Serre Ponçon Dam showing clay core and watertight cutoff through alluvia

ASME Technical Digest

Substance in Brief of Papers Presented at ASME Meetings

Production Engineering

Ceramic and Carbide Tool Performance Tests—Part I, by A. O. Schmidt, Mem. ASME, Kearney & Trecker Corporation, and Marquette University, Milwaukee, Wis.; I. Ham, University of Wisconsin, Madison, Wis.; W. I. Phillips and G. F. Wilson, Assoc. Mem. ASME, Kearney & Trecker Corporation, Milwaukee, Wis. 1956 ASME Annual Meeting paper No. **56—A-218** (multilithographed; available to Oct. 1, 1957).

THE experimental data on ceramic tool life in this report, although limited in scope, proved of value in application to production tests. Much work remains to be done in evaluating ceramic tool life for other workpiece materials and in explaining the manner of failure in ceramic tools which is different than in carbides. A more consistent or uniform wear process in ceramics may result from further improvement in the material.

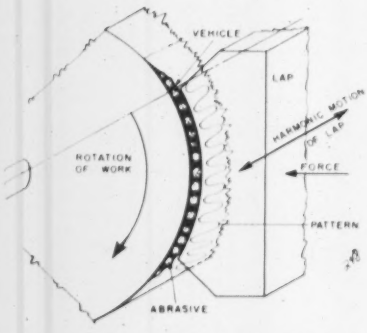
Observance of the factors which constitute good machining practice with any tool material, and especially carbides, is even more critical with ceramics in view of the brittle character of these materials. Proper holding of ceramic tips is of utmost importance. Adequate rigidity in the tool-workpiece-machine complex, freedom from excessive vibration, and sufficient power capacity in the machine tool, of importance in any machining operation, are even more essential with ceramics. Since these materials can be utilized to greater advantage at speeds higher than customary for carbides, sufficiently high speeds in machine tools must be made available.

It has already been demonstrated that for certain turning operations ceramics are the best tool material. Up to now ceramics have not worked as well in milling operations as have other tool materials, but it can be anticipated that this situation undoubtedly will be improved in the future as more experience and knowledge is acquired.

Attention once again must be focused on reducing the handling or load-and-idle time which constitutes a major part of the production cost in machining with carbide tools and, with ceramic tools, may account for as much as 90 per cent of the production cost of a machining operation. Although much remains to be learned about the technique of machining with ceramics, the great potential economic benefits to be derived from use of these materials in many cases is evident, especially in the mass production of machined parts with special or automated equipment having extremely low values of noncutting time. In essence these economies stem from the greater metal removal rates that are practical with ceramics and from the utilization of the concept of "throwaway" inserts which is admirably suited to these nonstrategic and relatively inexpensive materials. Such benefits have already been accomplished in isolated instances and more widespread exploitation is inevitable.

Ultrafinishing—A New High-Precision Lapping Process, by T. G. Lewis, Jr., E. I. du Pont de Nemours and Company, Wilmington, Del. 1956 ASME Annual Meeting paper No. **56—A-77** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

A NUMBER of important innovations have been made which permit the use of lapping for the production of exceptionally smooth metal surfaces with precise geometrical control. This body of patented techniques, called ultrafinishing, includes the necessary variations in velocity to permit the lapping of soft homogeneous and hard heterogeneous metals. The description of this process covers its similarity to lapping, its fields of application, and the response of materials from a metallurgical point of view. The application of this process can yield a 0.3 to 0.5-microin. finish rms with an over-all geometry control equal to or better than any commercial finishing method.



Components of lapping include lap, work, abrasive, vehicle, and pattern

Ultrafinishing is basically a modified lapping process which is made up of the five components of lapping; namely, lap, work, abrasive, vehicle, and pattern.

1 The lap is that part which applies a force to the abrasive particle causing it to abrade the work and itself.

2 The work is a surface to be refined to meet certain geometrical requirements. The refinement may be for surface finish only, or it may be for both surface finish and geometrical precision.

3 The vehicle is generally a liquid in which the abrasive particles are suspended. It also affords a film between the lap and the work.

4 The abrasive is a granulated substance having sufficient hardness to abrade the work and the lap.

5 The pattern is the configuration of the relative motion between the lap and the work.

Ultrafinishing is a series of patented techniques which differ from conventional lapping in one or more of the following respects:

1 The lap is restrained about one or more axes with respect to the surface being finished.

2 Control is exercised over the rate of change of shape of the lap by selection and combination of materials.

3 Critical attention is paid to the abrasive-supporting surface of the lap at each of the several stages of the lapping process.

Ultrafinishing techniques surpass all commercial finishing techniques when judged on the basis of (1) over-all geometry control, (2) cutting inclusions without dislodging them, (3) providing a finishing pattern with a depth of a few tenths of a microinch, and (4) finishing all constituents of the metal to equal elevation. No commercial process embraces all four of these items.

From the standpoint of economics, the low-velocity technique can be practiced at about half the cost of competing com-

mercial ones. Furthermore, the competing processes do not offer as good geometry control.

The high-velocity process does not offer the same economic advantages as competing processes. On the other hand, the competing processes do not yield a surface of equal quality. Therefore, for the manufacture of certain high-quality sheetlike materials, there is no substitute for ultrafinishing.

Hydraulics

Progress Report on Standardization of the Vibratory-Cavitation Test, by L. E. Robinson, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.; B. A. Holmes, Hydro-Electric Power Commission of Ontario, Toronto, Canada; and W. C. Leith, Dominion Engineering Works, Ltd., Montreal, Quebec, Canada. 1956 ASME Annual Meeting paper No. **56—A-85** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

A DESCRIPTION is given of the apparatus required for the accelerated testing of materials for relative resistance to cavitation damage by the magnetostrictive-vibratory method. Tentative standards of test conditions and test procedures are defined.

The magnetostrictive type of vibratory apparatus, which has a water-cooled centrally supported pure nickel tube as a transducer, is recommended for accelerated cavitation-resistance testing. A test specimen having a flat circular surface $^5/_8$-in. diam is suggested. The test liquid should be contained in a cylindrical flat-bottomed pyrex glass vessel approximately $3^1/_2$-in. diam and the container placed in a thermally regulated heat-exchange bath for control of the test-liquid temperature.

The following test conditions are suggested as tentative standards for vibratory, accelerated-cavitation testing

Test frequency of 6500 ± 50 cps.

Test amplitude of 0.00342 ± 0.00005 in.

Test liquid, fresh distilled water.

Test liquid temperature of 76 F ± 1 deg F.

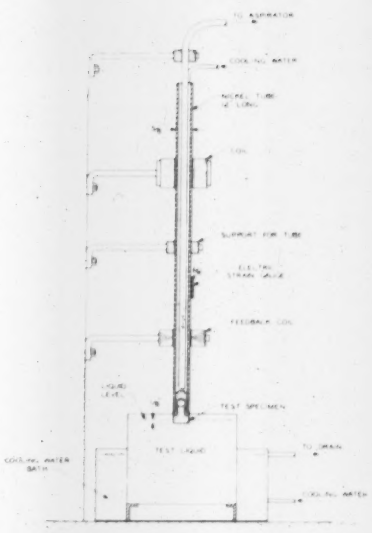
Test pressure, the prevailing barometric pressure, with the test results to be corrected to a reference pressure.

Submergence of test specimen of 0.125 in.

Test-liquid depth of 4.5 in. below the test specimen.

Test time of 120 min divided into four equal intervals.

The following procedures are suggested as tentative standards for vibratory resistance tests:



Schematic layout of vibratory-type, accelerated-cavitation machine

The distilled water should be prepared for test by boiling for 15 min to reduce the air content to a minimum.

A root-mean-square roughness of three microinches should be obtained on the flat circular test surface of the specimen, using triple-zero emery paper.

The specimen should be stabilized in state of oxidation and water content by the following sequence: Boil for 15 min in distilled water, soak to ambient temperature in distilled water, and surface-dry with CP reagent acetone immediately before each weighing and testing.

The specimen should be taken from the vibratory apparatus at the end of each 30-min interval of testing, surface-dried, and weighed. All weights should be taken to the nearest $^1/_{10}$ milligram.

Compensation of Steady-State Flow Forces in Spool-Type Hydraulic Valves, by R. N. Clark, Minneapolis-Honeywell Regulator Company, Minneapolis, Minn. 1956 ASME Annual Meeting paper No. **56—A-121** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

THREE heretofore unreported schemes for reducing the steady-state flow forces in spool-type hydraulic valves are described. Experimental data are presented which compare the steady-state flow-force characteristics of valves using each of these schemes to the characteristics of uncompensated valves. These schemes will allow considerable design flexibility.

Equivalent Performance Parameters for Turboblowers and Compressors, by Hunt Davis, Mem. ASME, Worthington Corporation, Harrison, N. J. 1956 ASME Annual Meeting paper No. **56—A-122** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

THE author defines the parameters of equivalent performance for turbocompressors and shows how they may be used for correlation of shop and field testing with design information. Three classifications of correlation are defined with different degrees of correlation accuracy. The first class includes cases where the correlation error is negligibly small, even when the test fluid is different from the design fluid. The second class includes cases where the correlation accuracy is reasonably good. The third class offers no satisfactory correlation conditions. It is proposed that similar concepts of correlation be recognized by and incorporated into the appropriate Power Test Code for turbocompressors.

Losses in Pipe and Fittings, by R. J. S. Pigott, Fellow ASME, Pittsburgh, Pa. 1956 ASME Annual Meeting paper No. **56—A-63** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

THE purpose of this paper, as of that in 1950, is simply to attempt a more nearly rational and consistent method of computing pipeline losses, to replace the usual guessing at k, with a range of 2 or 3 to 1 in the choice. Since we are now dealing in quite a few practical cases with much higher velocities than formerly, it becomes much more important that we calculate losses more accurately. In many cases the friction loss in a pipe line may be a means of regulating a process. In one case such as this, the loss calculated by the values published by manufacturers and in the handbooks gave results nearly four times those calculated by the author's 1950 data. This difference would entirely change the requirements for the pumping system. A test on a completed layout showed the 1950 formulation to be quite close to the facts. The manufacturers' data admittedly had included 35 to 50 per cent above test results, and many of the handbook data are also placed well on the "safe" side. This kind of estimating is satisfactory for, say, a line from boiler to turbine, where the total line loss is a small fraction of the operating pressure, but it is not of much use for close design of a gas-distributing system, or for a closed-system process in which the line loss constitutes practically the whole load.

It would appear that if a real knowledge of bend losses is to be attained, we

must consider a comprehensive research to get modern and more accurate data on the whole range of roughness and bend radius, using suitable instruments to measure and classify roughness. Such a program would cost more than any one or two companies, for example, would care to undertake. It would therefore have to be a joint affair, like the ASME Fluid Meters Committee's work on orifices, or the earlier work on properties of steam. This broad interest type of work is often handled by more than one national society, jointly. In the present subject, the American Gas Association, the American Petroleum Institute, and the American Water Works Association would be as much interested as THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Jet-Pump Theory and Performance With Fluids of High Viscosity, by R. G. Cunningham, Assoc. Mem. ASME, Shell Oil Company, Wood River, Ill. 1956 ASME Annual Meeting paper No. **56—A-58** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

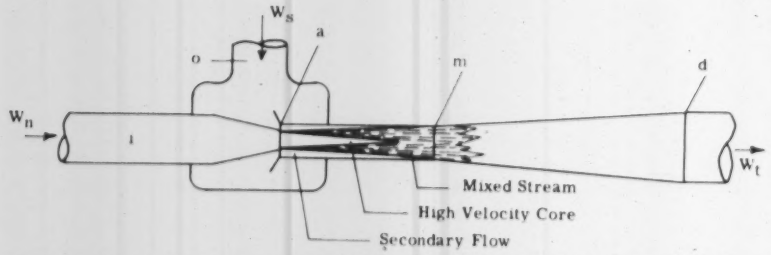
PERFORMANCE characteristics of the jet pump when handling viscous oil have been established. Theoretical relations describing the jet pump are developed in this paper in terms of dimensionless ratios and friction coefficients. In addition, an energy analysis is made which separates friction losses and unavoidable mixing losses. In an experimental program eight jet pumps, with nozzle-to-throat area ratios of 0.1 to 0.6, were operated over a range of jet Reynolds numbers from 700 to 30,000. Mineral and synthetic lubricating oils used covered a 5 to 100-centistoke viscosity range of the jet fluid. The results of these theoretical and experimental studies permit application of the jet pump to lubication systems. For design use the experimental data are reduced to friction coefficients and correlated versus jet and throat Reynolds numbers. To facilitate rapid estimates of viscosity effects, simplified empirical relations are also included. It is concluded from this study that the jet pump is indeed suitable for use with viscous fluids.

Computer Representations of Engineering Systems Involving Fluid Transients, by F. D. Ezekiel, Mem. ASME, and H. M. Paynter, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1956 ASME Annual Meeting paper No. **56—A-120** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

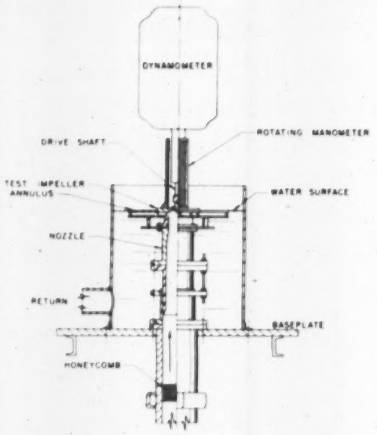
APPLICATIONS of modern analog and digital computing machines to engineering solutions of fluid-transient problems are discussed. Methods for computer representations of various physical elements commonly used in hydraulic and pneumatic systems such as conduits, valves, pumps, and so forth, are described. These are presented in such forms that they can be incorporated readily as component parts into a simulated engineering installation. Such methods permit rapid determination of critical dimensions as well as ready exploration of alternatives for balances between cost and performance.

An Experimental Study of Centrifugal-Pump Impellers, by A. J. Acosta, Office of Naval Research, Contract N6onr-244, Task Order II, and R. D. Bowerman, Assoc. Mem. ASME, California Institute of Technology, Pasadena, Calif. 1956 ASME Annual Meeting paper No. **56—A-41** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

EXPERIMENTAL investigations were made on four two-dimensional impellers and on a well-designed commercial three-dimensional Francis impeller. The overall performance of each of these impellers was measured and internal-energy loss and pressure-distribution data were also obtained for several impellers. The exit angle of the two-dimensional impellers was fixed and the inlet angle was systematically varied. However, the hydraulic characteristics of these impellers were all found to differ, the source of the variation being in the various loss distributions and hence internal flow patterns in the impellers. The two-dimensional and three-dimensional impeller-loss distributions were also different. The Francis impeller performance agreed better with potential theory than that of the two-dimensional impellers, and it is concluded that the different loss distributions of the two types are responsible.



Jet pump, showing mixing process. Mixing occurs between the jet fluid and the low-velocity fluid; and transfer of momenta accelerates the latter in the direction of flow.



Cross section of impeller and test-basin assembly

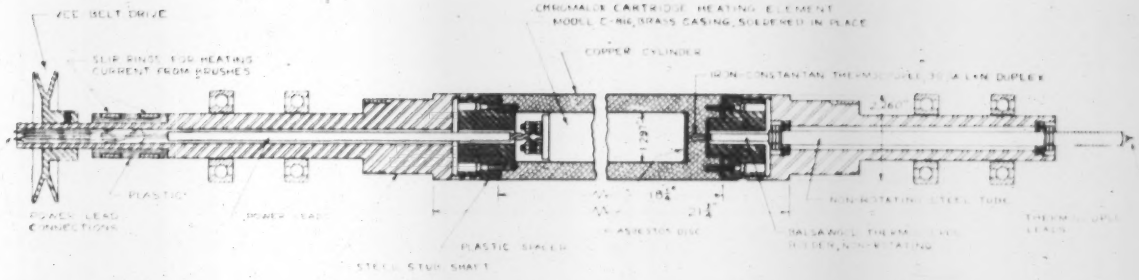
Heat Transfer

Transient Air Temperatures in a Duct, by S. E. Rea, engineer, Boeing Airplane Company, Seattle, Wash., and C. M. Ablow, mathematician, Stanford Research Institute, Menlo Park, Calif. 1956 ASME Annual Meeting paper No. **56—A-70** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

TRANSIENT temperatures in a thin-walled duct carrying heated air are investigated experimentally and theoretically. The simplified theory applies to turbulent liquid or low-speed gas flow. The duct wall is shown to be an important heat reservoir.

It is concluded that the use of a simplified theory and modern high-speed computing methods yields fairly accurate preliminary design information on the temperature lag in ducts. The duct walls participate in downstream-temperature variations in an important way.

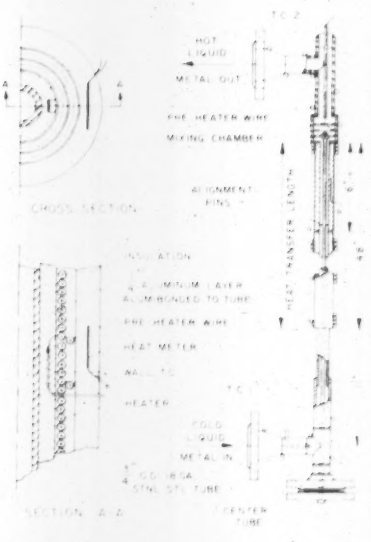
Discrepancies between theory and experiment for the present study are traced to (*a*) inaccuracies in flow-speed measurement, (*b*) uncertainties in the heat-transfer coefficient, and (*c*) oversimplification of the theory.



Construction details of heat rotating cylinder—the basic element of the apparatus used to determine the heat transfer

Heat Transfer to Lead-Bismuth in Turbulent Flow in an Annulus, by R. A. Seban, Mem. ASME, University of California, Berkeley, Calif., and D. F. Casey, Assoc. Mem. ASME, Atomics International, North American Aviation, Inc., Canoga Park, Calif. 1956 ASME Annual Meeting paper No. **56—A-62** (in type; to be published in Trans. ASME, available to Oct. 1, 1957).

HEAT-TRANSFER coefficients for molten lead-bismuth eutectic are presented for flow in annuli externally heated at a constant rate. Diameter ratios of 1.30 and 1.74 were investigated and results were obtained for Peclet numbers from 400 to 1600. These results are shown to be related to analogy predictions for this system in the same manner as exists for pipe flow, and that the theories providing a rationalization of the results for pipe flow do so as well for the flow in an annulus.



Details of the test section used to calculate heat transfer to lead-bismuth in cumular flow

A Theoretical Analysis of Heat Transfer in Natural Convection and in Boiling, by Yan Po Chang, Taiwan College of Engineering, Taiwan, China. 1956 ASME Annual Meeting paper No. **56—A-42** (in type; to be published in Trans. ASME, available to Oct. 1, 1957).

A THEORETICAL analysis of natural convection and of boiling heat transfer is presented. Instead of approaching these problems according to a conventional concept, a short-cut method is introduced by the application of wave motion. Above the heating surface a boundary layer is assumed whose thickness depends upon the heat flow. Inside this layer there is wave motion, stable in the lower part but unstable in the upper. It has been recognized that, if there is a temperature gradient across a stratum of liquid, a wave motion will occur. Each loop of this wave can initiate vortexes in the natural-convection process and also can facilitate the formation of bubbles in boiling. A unified formula is thus obtained for convection and for boiling. The calculated results agree excellently with experiments as conducted by previous investigators. This paper does not profess to be a complete treatise, but shows how the concept of wave motion can be made of use in giving a new picture of these heat-transfer processes.

Heat Transfer From a Rotating Cylinder With and Without Cross Flow, by W. M. Kays, Mem. ASME, and I. S. Bjorklund, Stanford University, Stanford, Calif. 1956 ASME Annual Meeting paper No. **56—A-71** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

THE problem of convection heat transfer from a rotating cylinder is extended to the case of a cross, or normal flow to the cylinder. Experimental heat-transfer data are presented for a cylinder rotating with and without cross flow. The data for the cylinder rotating with no cross flow are in substantial agreement with the results of previous work, and also with the results of a heat-and-momentum-transfer-analogy solution for convection with no cross flow. Measured temperature profiles in the boundary layer of the heated rotating cylinder are in very good agreement with the analogy solution, and indicate that the boundary layer on a rotating cylinder is quite similar to a turbulent boundary layer on a stationary surface out to about $y^+ = 20$. Thereafter a secondary flow becomes the controlling mechanism. The experiments with combined rotation and cross flow indicate two flow regimes; the first for the cylinder peripheral velocity less than twice the cross-flow velocity, in which the cross flow provides the controlling effects; the second for the cylinder peripheral velocity greater than twice the cross-flow velocity, in which there is a continuous boundary layer around the cylinder and the rotational velocity provides the controlling effects on heat transfer. It is shown that the combined effects of rotation, free convection, and cross flow can be correlated by the equation

The Viscosity of Five Gases: A Re-Evaluation, by J. Kestin and H. E. Wang, Brown University, Providence, R. I. 1956 ASME Annual Meeting paper No. **56—A-72** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

THE paper contains a re-evaluation of the experimental results for the pressure dependence of viscosity obtained by Pilarczyk and described by Kestin and Pilarczyk. The re-evaluation is based on an improved theory of the oscillating-disk viscometer described by Kestin and Wang. The results for air, nitrogen, argon, helium, and hydrogen are given in graphical and tabular form as well as in the form of empirical equations. The range covered is 1 to 70 atm at 25 C. The results constitute a relative measurement which is based on Gibson and Michels' data for nitrogen. Very good agreement

Table 1 Viscosity of Five Gases at 25 C and at Different Pressures—μ-Poise

p atm	Nitrogen N_2	Air	Argon A	Helium He	Hydrogen H_2
1	1778×10^{-7}	1839×10^{-7}	2262×10^{-7}	1984×10^{-7}	892.3×10^{-7}
2	1780	1841	2264	1984	892.4
5	1784	1845	2270	1984	892.8
10	1793	1854	2281	1985	893.5
20	1809	1872	2305	1985	894.8
30	1827	1890	2330	1987	896.3
40	1846	1911	2357	1989	898.0
50	1867	1932	2386	1992	900.1
60	1890	1954	2417	1996[a]	902.8
70	1916	1978	2449	2000[a]	906.3
80	1946[a]	2020[a]	2483[a]	2006[a]	910.6[a]
90	1978[a]	2053[a]	2519[a]		916.6[a]
100	2015[a]	2088[a]	2556[a]		922.6[a]

[a] Extrapolated.

with previously published data for nitrogen, air, and hydrogen has been reported. In the case of helium no comparative data could be found, and in the case of argon there is good agreement with the data published by Michels and others but the difference in absolute values is somewhat higher than for the preceding three gases. The agreement as to rate of change with pressure is excellent. It is believed that the data now reported contain an uncertainty of no more than 0.2 per cent for nitrogen, air, hydrogen, and helium and of not more than 0.6 per cent for argon with respect to nitrogen. The data are summarized in Table 1.

Metals Engineering

The Flow and Fracture of Nodular Cast Iron, by W. R. Clough, The Electro Metallurgical Company, Division of Union Carbide and Carbon Corporation, Niagara Falls, N. Y., and M. E. Shank, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1956 ASME Annual Meeting paper No. **56—A-110** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

COMBINED stress on pearlitic nodular iron shows this material possesses a constant valued modulus of elasticity and Poisson's ratio. The maximum shear criterion for yielding is conservative, but is sufficiently accurate for design purposes. In addition, it appears to yield in accordance with the distortion-energy theory, providing stress concentrations at the graphite nodules are taken into account. There is a density change with plastic deformation due to separation of the matrix from the graphite. Stress and strain variables may be reasonably correlated by plotting plastic work against octahedral shear stress. A smooth fracture envelope has been obtained, and fracture occurs in a direction normal to the greatest applied tensile stress. A considerable internal crack network may be opened up before fracture. Brittle cleavage facets in pearlitic nodular iron are revealed by the fractographic technique. Cleavage fracture is not obtained in ferritic nodular iron in tension, but may be obtained in the presence of notches or by low temperature of test.

Nonhomogeneous Yielding of Steel Cylinders; I—Mild Steel, by M. C. Steele and L. C. Eichberger, University of Illinois, Urbana, Ill. 1956 ASME Annual Meeting paper No. **56—A-39** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

EXPERIMENTAL information on the mechanism of yield and the associated strains is presented for mild-steel cylinders (2:1 diameter ratio) overstrained by internal fluid pressure. A limited number of Lüders' lines develop and propagate through the cylinder wall according to distinct patterns. The strains vary circumferentially in keeping with the nonhomogeneous mechanism of yield. Comparison with homogeneous plasticity theories shows good agreement for circumferential strains provided a correction is made for the material yield stress. Axial strains are essentially elastic. Creep under maintained constant load is discussed in relation to strain and Lüders' line movement.

Creep Characteristics of Type 347 Stainless Steel at 1050 and 1100 F in Tension and Compression, by M. J. Manjoine, Mem. ASME, Westinghouse Research Annual Meeting paper No. **56—A-40** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

COLD-DRAWN and stress-relieved Type 347 heavy-wall tubing flows plastically at service temperatures (1050-1100 F) when subjected to a stress below the 10,000-hr rupture strength. The precipitation induced by the strain and temperature conditions causes an extended period of abnormally high creep resistance. The duration of this period increases with decreasing stress and is longer for compression than for tension. The creep and rupture strengths for service duration over 10,000 hr are poorer than those reported for Type 347 annealed bar stock.

Delayed-Yield Time Effects in Mild Steel Under Oscillatory Axial Loads, by R. O. Belsheim, Assoc. Mem. ASME, Naval Research Laboratory, Washington, D. C. 1956 ASME Annual Meeting paper No. **56—A-108** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

AN APPARATUS was developed which loads a tension specimen by a vibratory load superimposed on a static load. Tests of mild steel produced (*a*) dynamic yield points 5 to 50 per cent above the static yield point, and (*b*) corresponding delayed-yield times of 1000 to 10 millisec. These results showed general agreement with the results of other investigations.

Influence of Repeated Bending Loads on Biaxial Residual Stresses in Shot-Peened Plates, by T. M. Elsesser, University of Illinois, Urbana, Ill. 1956 ASME Annual Meeting paper No. **56—A-109** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

THE futility of shot-peening certain members to increase their fatigue strength may be explained by the reduction of the initial residual stresses with increased numbers of repeated loads. The purpose of this investigation was to determine the changes in the biaxial residual stresses, induced by shot-peening, in steel plates subjected to cyclic bending loads. The plates were sectioned by etching, and curvature measurements were made to evaluate the residual-stress distributions in the region of the peened surface. The residual stresses were found to "fade" or decrease to at least 50 per cent of their initial value in 10,200 load cycles in the medium-hard (SAE 4340) steel investigated.

Instruments and Regulators

Responses of Temperature-Sensing-Element Analogs, by G. A. Coon, Mathematician, Taylor Instrument Companies. 1956 ASME Annual Meeting paper No. **56—A-101** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

FROM the standpoint of stability, temperature-sensing elements used in control systems should not contribute

much phase lag at the frequency where the open-loop phase lag is 180 deg. For those cases where the temperature-sensing element does not contribute appreciable (less than 30 deg) phase lag around 180 deg, it would be advantageous to have a low-frequency approximation which works for complicated thermal systems. This paper presents such an approximation and establishes its validity for the electrical analogs of many sensing elements. In addition, it shows how the approximation is related to the thermal lag measured during a ramp input and the 63 per cent response time. These results, which are obtained in terms of transfer functions, can be applied to other systems having the same analogs.

Method for Presenting the Response of Temperature-Measuring Systems, by Robert Looney, Assoc. Mem. ASME, Taylor Instrument Companies. 1956 ASME Annual Meeting paper No. **56—A-102** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

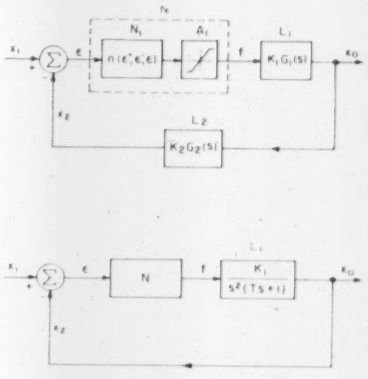
A SINGLE time-constant approximation of the lag of temperature-measuring systems is often adequate for evaluating the effect of the system lag on the control loop and for indicating the fidelity with which transients are recorded. The value of this approximate time constant is dependent upon the system and on the properties of the fluid whose temperature is being controlled. This paper suggests a method of presenting information on systems from which the user can determine the single time-constant approximation for his operating conditions. Experimental procedures for obtaining the necessary information are discussed.

Design Basis for Cascade-Type Positional Servomechanisms, by Sidney Lees, Massachusetts Institute of Technology, Cambridge, Mass. and T. C. Blaschke, Sperry Gyroscope Company, Lake Success, N. Y. 1956 ASME Annual Meeting paper No. **56—A-105** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

A DESIGN basis, previously developed for multiloop positional servomechanisms, has been extended to cascade-type systems. The design basis attempts to co-ordinate specifications, dynamic characteristics, interferences, and uncertainties from a consideration of the generation of torques by the system. The limitations of the system performance are distinguished from component characteristics. The concept of frequency-dependent coefficients is applied to the lead-modifier damping model, the lag-modifier viscous damping model, and to the lag-modifier lead-modifier damping model. It is shown that the performance may be understood from knowledge of second-order systems. Estimates of useful values of the parameters for each model are confirmed by analog studies.

The Phase-Space Method for Analysis of Nonlinear Control Systems, by Y. H. Ku, University of Pennsylvania, Philadelphia, Pa. 1956 ASME Annual Meeting paper No. **56—A-103** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

THIS paper gives a general procedure for the analysis of a feedback system with a nonlinear control function. Taking the actuating signal as the dependent variable, a single nonlinear differential equation is obtained, the order of which depends upon the complexity of the linear transfer functions. This high-order nonlinear differential equation is then solvable by the phase-space method developed by the



Block diagram of feedback system with nonlinear control and limiter

author and detailed in his previous papers. The method is further extended to the analysis of a system with one nonlinear controller in the forward branch and another nonlinear controller in the feedback branch. The two phase-plane equations obtained from the simultaneous differential equations are then solvable by a previous method.

Pressure-Flow Characteristics of Pneumatic Valves, by F. D. Ezekiel, Assoc. Mem. ASME, and J. L. Shearer, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1956 ASME Annual Meeting paper **56—A-104** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

IN THIS paper, the pressure-flow characteristics are derived from equations that hold for frictionless flow of perfect and semiperfect gases. Because the viscosity of most commonly used gases is at least two orders of magnitude less than commonly used hydraulic fluids, the effects of friction in control-valve orifices are almost always negligible. Commonly used gases such as air, nitrogen, products of combustion, and the like, are usually used in a range of states that is sufficiently far enough away from their critical points and liquid states to consider them as perfect or semiperfect gases. This is true, for instance, of air at pressures below 3000 psi and temperatures above 350 R. Also, many of the significant conclusions that come out of work with perfect and semiperfect gases may be applied qualitatively to cases where the behavior of the gas departs considerably from the perfect gas equations. This is true, for instance, when steam is used without much superheat, as long as none of it condenses to liquid water.

Machine Design

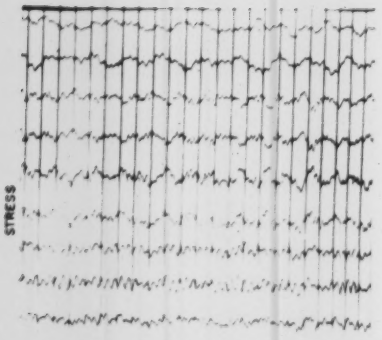
Effects of Complex Stress-Time Cycles on the Fatigue Properties of Metals, by W. L. Starkey, Assoc. Mem. ASME, and S. M. Marco, Assoc. Mem. ASME, Ohio State University, Columbus, Ohio. 1956 ASME Annual Meeting paper No. **56—A-1** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

AN INVESTIGATION was conducted to determine the effects of complex stress-time cycles on the fatigue properties of metals. The uniaxial stresses studied were complex in the sense that their stress-time patterns may be analyzed as composed of several harmonic components. Four theoretical design methods, and the results of an experimental investigation involving complex stresses are presented. Comparisons are made of the test results with the theory predictions.

Many of the machines of the present day are high-performance machines. Such machines must be capable of developing high power capacities but must simultaneously be light in weight and of small volume.

High-performance machines are often subjected to forces which induce in the individual members complex stress-time cycles. The design of machine members subjected to such stresses involves an area of the fatigue problem which has not yet been investigated systematically.

It would be useful to establish relationships by means of which the effects of complex stress-time patterns on endurance properties could be estimated on the basis of knowledge of simple stress-cycle data. Relationships of this type may be developed theoretically and evaluated experimentally by performing controlled



Complex stress-time relationships for various points of an aircraft propeller recorded by electric strain gages

tests with a testing machine capable of inducing complex stresses in specimens of simple geometry. By such a procedure it should be possible to devise a generalized design method which utilizes simple completely reversed uniaxial endurance properties as the basic design data.

This paper presents relationships which correlate the effects of complex stresses with simple failure data, and presents the results of a testing program conducted to obtain experimental data involving complex stresses.

Fatigue of Metals Under Combinations of Stresses, by W. N. Findley, Brown University, Providence, R. I. 1956 ASME Annual Meeting paper No. **56—A-74** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

ANALYSIS of available information suggests that the phenomenon of fatigue of materials results primarily from alternating shearing stress producing cracks along shear planes, and that the resistance to fatigue cracking is influenced by other factors. Some of these factors are changes in structure of the material resulting from plastic and elastic stressing as well as heat-treatment; the mode of crack propagation and the complementary normal stress on planes of shear stress. Several theories of failure under combined stress are examined and modified to account for observed facts. A general design expression is proposed. The influence of mean stress (including extreme compression), yielding, complementary normal stress, and anisotropy are considered.

Repeated shear stress seems to be the cause of fatigue fractures with other factors such as complementary normal stress and anisotropy as modifying influences which are operative under combined stressing, according to the conclusions.

The phenomenological theories for fatigue under combined stress require correction for these influences. Modifications proposed yield expressions which are satisfactory for combined bending and torsion. Additional data at other combinations of stress are needed to evaluate the theory, and a better understanding of the origin of fatigue at the atomic level of action is needed.

Vibration Design Charts, by J. N. MacDuff, Mem. ASME, Duke University, Durham, N. C. and R. P. Felgar, General Electric Company, Schenectady, N. Y. 1956 ASME Annual Meeting paper No. **56—A-75** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

THE charts, tables, and nomographs presented in this paper were prepared to provide a quick procedure for estimating natural frequencies of uniform and nonuniform beams and uniform plates. This enables the designer to assess the effect of changing the dimensions, type of support, and material of the element.

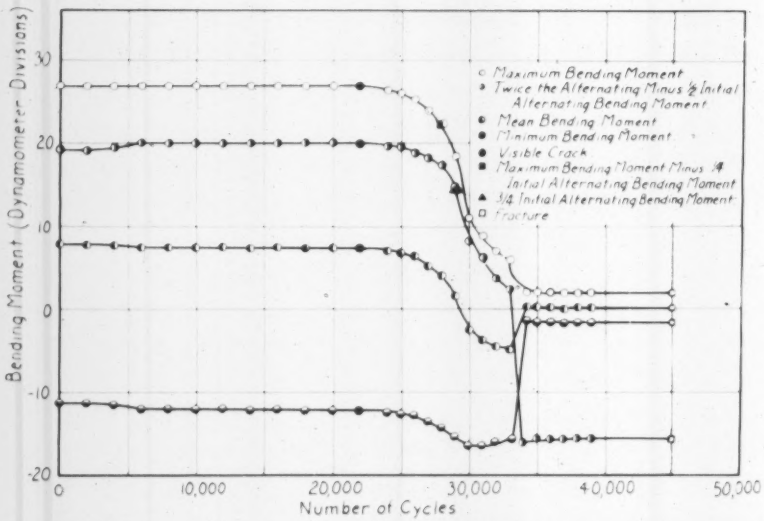
The data for the tables presented in the paper were obtained from readily available references. Undoubtedly, some information available in the literature has been omitted. It is expected that, from time to time in the future, the tables will be modified and additional information added.

The theory underlying the data given for the natural frequencies of beams and plates assumes small deflections and neglects rotary inertia and shear effects. These restrictions must be kept in mind when determining frequencies from the charts.

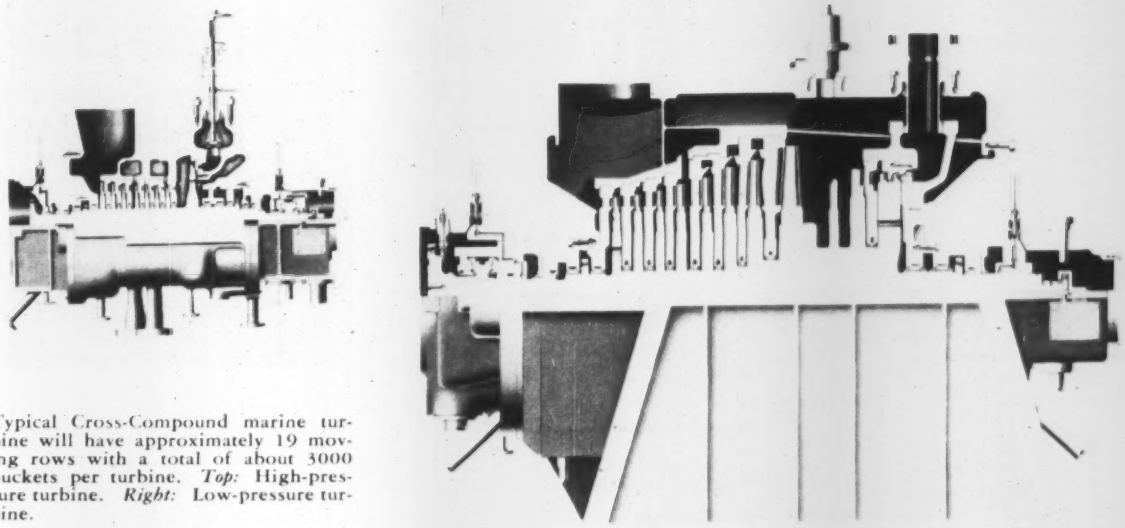
Steam Power Generation

A Method for Calculating Vibration Frequency and Stress of a Banded Group of Turbine Buckets, by M. A. Prohl, Mem. ASME, General Electric Company, West Lynn, Mass. 1956 ASME Annual Meeting paper No. **56—A-116** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

STEAM-TURBINE buckets are normally covered at the tips by a band. The band is applied in segments, each segment elastically joining together a given number of buckets. In studying vibrational behavior the buckets should be treated as banded groups rather than as individual cantilevers. A method of analysis, suitable for digital computation, is presented which gives all of the natural frequencies and mode shapes of a banded group of buckets subject to the usual limitations of the elementary beam theory. Axial and torsional motion as well as tangential is considered. Also a procedure is included for evaluating vibration amplitude and stress at resonance. Damping is assumed to be small and the energy input to the banded group from a prescribed form of nozzle stimulus is equated to the energy dissipated in damping to determine vibration-stress levels. Sample calculations have been made on the IBM Electronic Data Processing Machine, Type 704, and the results of



Typical bending-moment history of a specimen of 25S-T aluminum alloy subjected to 45,000 cycles of stress initial values of which were 20,000 psi mean stress and 40,000 psi alternating stress



Typical Cross-Compound marine turbine will have approximately 19 moving rows with a total of about 3000 buckets per turbine. *Top:* **High-pressure turbine.** *Right:* **Low-pressure turbine.**

these calculations are given in a companion paper (No. 56—A-119), a digest of which follows.

High Frequency Vibration of Steam-Turbine Buckets, by F. L. Weaver, Mem. ASME, and M. A. Prohl, Mem. ASME, General Electric Company, West Lynn, Mass. 1956 ASME Annual Meeting paper No. **56—A-119** (in type; to be published in Trans. ASME, available to Oct. 1, 1957).

THE design of short and medium-height steam-turbine buckets is discussed with regard to the possibility of resonant vibration at the frequency of passing nozzles or multiples of this frequency. Particular attention is given to the design problems involved in marine applications.

A new calculation procedure is used to obtain the various natural frequencies (tangential, axial, and torsional) of a banded group of buckets and the related mode forms and vibration-stress levels. Calculation results obtained on the IBM Electronic Data Processing Machine, Type 704, are presented and are discussed with relation to their influence on bucket design.

It is concluded that marine propulsion turbines may operate for considerable periods of time at speeds where certain buckets will vibrate in resonance with the nozzle stimulus. Determination of the natural frequencies of vibration of these buckets and the evaluation of stresses at these resonant responses is an important part of bucket design. The advent of the modern digital computer now makes it practical to apply more thorough and more exact procedures of analysis to this vibration problem. The analytical procedures employed in this paper are considered to represent a significant advance along these lines. The use of these methods in the study of bucket vibration and the correlation of calculated performance with measurement and with experience will result in continuing progress in this important field.

Power Test Codes

Cooling Towers for Steam-Electric Stations—Selection and Performance Experiences, by M. W. Larmoff, Mem. ASME, Ebasco Services, Inc. 1956 ASME Annual Meeting paper No. **56—A-59** (in type; to be published in Trans. ASME, available to Oct. 1, 1957).

COOLING towers are an important element in the plans of tomorrow's steam-electric generating stations. Their outstanding advantage is the flexibility which they offer to new plant locations. Their present short-comings, by comparison with experienced power-plant standards, are generally their short service life, high maintenance costs, and thermal-performance deficiencies and losses.

Cooling-tower owners with towers less than 10 years old who have already spent more than 50 per cent of the initial tower cost for maintenance probably could have well afforded a concrete-shell cooling tower with a fill of noncorrosive metal or some plastic material lasting perhaps 30 to 40 years. The answer to a dependable, durable and economic cooling tower may not be in today's redwood towers nor in an indestructible substitute-material tower, but it must lie somewhere between.

The responsibility for the design and development of a more dependable and longer life cooling tower lies in the hands of the manufacturer. The cooling-tower industry should solve the problems facing the purchasers and users today by establishing acceptable minimum standards of thermal performance and structural and mechanical durability. By doing so, the industry will prepare itself to successfully meet the expanding future needs of the electric utility industry and grow in an atmosphere of confidence.

ASME Transactions

THE January, 1957, issue of the Transactions of the ASME (available at $1 per copy to ASME members, $1.50 to nonmembers), contains the following:

Technical Papers

The Springback of Metals, by E. J. Gardiner. (55—A-66)

Design Study of a Hydrostatic Gas Bearing With Inherent Orifice Compensation, by S. K. Grimnell and H. H. Richardson. (55—A-177)

Specific Heats of Liquid Metals and Liquid Salts, by T. B. Douglas.

Fuel Elements for Nuclear Reactors, by J. B. Anderson.

Reactor Shielding, by E. P. Blizard.

Safeguard Features of a Fast-Breeder-Reactor Power Plant, by W. J. McCarthy, Jr., and F. C. McMath.

Methods of Refueling Heterogeneous Nuclear Reactors, by Stuart McLain, A. H. Barnes, and R. C. Goertz.

Design of Corrugated Diaphragms, by J. A. Haringx. (55—A-112)

Investigations of the Properties of Corrugated Diaphragms, by W. A. Wildhack, R. F. Dressler, and E. C. Lloyd. (55—A-181)

Recent Research on Flat Diaphragms and Circular Plates With Particular Reference to Instrument Applications, by A. M. Wahl. (55—A-116)

Effect of Surface Finish on the Fatigue Strength of Titanium Alloys RC 130B and Ti 140A, by G. M. Sinclair, H. T. Corten, and T. J. Dolan. (55—A-197)

Certain Departures From Plastic Ideality at Small Strains, by H. A. Lequear and J. D. Lubahn. (55—A-151)

On the Applicability of Notch Tensile Test Data to Strength Criteria in Engineering Design, by J. D. Lubahn. (55—A-149)

Creep Damage in a Cr-Mo-V Steel as Measured by Retained Stress Rupture Properties, by M. H. Jones, D. P. Newman, and W. F. Brown, Jr. (55—A-175)

Some Studies of Angle Relationships in Metal Cutting, by J. H. Creveling, T. F. Jordan, and E. G. Thomsen. (55—A-125)

On the Drilling of Metals, 2—The Torque and Thrust in Drilling, by M. C. Shaw and C. J. Oxford, Jr.

Influence of Grinding Fluids Upon Residual Stresses in Hardened Steel, by H. R. Letner. (55—A-123)

Residual Stresses in Cold Extruded Aluminum, by J. Frisch and E. G. Thomsen. (55—A-27)

Plant Management and Other Factors Affecting Maintenance Costs in Steam-Generating Stations, by V. F. Estcourt. (55—A-87)

Maintenance Factors Affecting Production Costs, by W. F. Oberhuber and C. W. Watson. (55—A-128)

Fluid Flow Through Two Orifices in Series, III—The Parameters of Metastable and Stable Flow of Hot Water, by W. J. Kinderman and E. W. Wales. (55—A-192)

Availability List of Unpublished ASME Papers

A NUMBER of papers and reports were presented at ASME Meetings which were not preprinted or published. Manuscript copies of these papers are on file for reference purposes in the Engineering Societies Library, 29 West 39th Street, New York 18, N. Y. Photostatic copies of these unpublished papers may be secured from the Library at the rate of 40 cents per page. The following papers recently have been placed on file in the Engineering Societies Library:

1955 Nuclear Engineering and Science Congress

Steady State and Transient Heat Transfer Problem in Water-Cooled Reactors, by L. S. Mims

Proposed Structural Design Basis for Nuclear Reactor Pressure Vessels, by W. E. Cooper

Design and Development of Components for the SRE, by W. E. Parkins

A Pyrometallurgical Processing Method for Nuclear Fuels, by Members of the Chemical Engineering Division

1956 ASME Spring Meeting

Design of Graphite Moderated Power Reactors, by A. B. Carson

Joint 1956 EIC-ASME-ARS Meeting

Air Pollution Control Problems, by E. A. Allcut

1956 ASME Semi-Annual Meeting

High Impact Plastics as Engineering Materials, by F. L. Ingley and P. J. Meeks

A Deceleration Probe for Measuring Stagnation Pressure and Velocity of a Particle-Laden Gas Stream, by J. L. Doussard and A. H. Shapiro

1956 ASME Fall Meeting

Economic Lot Size Formulas in Manufacturing, by A. Vasonyi

Economic Lot Sizes for Some Elementary Inventory Systems, by E. Naddor

1956 ASME Petroleum Mechanical Engineering Conference

Design Applications for Air Drilling Equipment, by V. A. La Fave

Drilling Rig Maintenance Costs, by R. W. True

A Comparison of the Application of Various Fluid Drives to Oilfield Drilling Rigs, by W. A. Eskridge

1956 ASME Annual Meeting

Trends and Prospects in the Coal Industry, by P. D. Teitelbaum

Influence of Heat Treatment on the 1000 F and 1050 F Properties of Steam Pipe Made in Japan and Germany From 1.25 Cr-0.50 Mo and 2.25 Cr-1.0 Mo Steels on the Effect of Temperature on the Properties of Metal, by J. W. Freeman and I. A. Rohrig

The Development of the Heat Pump and Its Application in the Chicago Area, by T. R. Kroeschell

Basis for the Design and Retirement of Petroleum Heater Tubes, by J. J. Heller

The Design and Operation of an Electrical Analog of a Reciprocating Compressor Installation, by J. V. Hughes and J. M. Sharp

ASME Papers Order Form

Copies of ASME technical papers digested this month are available in pamphlet form. Please order only by paper *number;* otherwise the order will be returned. Orders should be addressed to the ASME Order Department, 29 W. 39th St., New York 18, N. Y. Papers are priced at 25 cents each to members; 50 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons distributed annually to members, or coupons which may be purchased from the Society. The coupons, in lots of ten, are $2 to members; $4 to nonmembers.

Note: No digests are made of ASME papers published in full or condensed form in other sections of MECHANICAL ENGINEERING.

Copies of all ASME publications are on file in the Engineering Societies Library and are indexed by the Engineering Index, Inc., both at 29 West 39th Street, New York, N. Y.

ASME Transactions and the *Journal of Applied Mechanics* are on file in the main public libraries of large industrial cities and in the technical libraries of engineering colleges having ASME Student Branches.

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Please send me the papers indicated by the following circled numbers:

56—A-1	56—A-85
56—A-39	56—A-101
56—A-40	56—A-102
56—A-41	56—A-103
56—A-42	56—A-104
56—A-58	56—A-105
56—A-59	56—A-108
56—A-62	56—A-109
56—A-63	56—A-110
56—A-70	56—A-116
56—A-71	56—A-119
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Comments on Papers

Including Letters From Readers on Miscellaneous Subjects

Multifuel Firing

Comments by N. E. Sylvander[1] and C. W. Zielke[2]

THE opportunity to add comment to this paper[3] is appreciated. After complimenting G. A. Watts on a most worthy presentation, we would specifically like to amplify somewhat on the use of a low-temperature carbonization product—CHAR—as a boiler fuel.

The chief difference in burning low-temperature carbonization char as compared to burning high volatile bituminous coal is found in the severity of conditions required for ignition. Once good strong ignition is achieved and maintained, the combustion rates of the char and devolatilized coal residue are about the same. Burning-rate indexes obtained by B&W on solid fuels of all types support this contention. Confirmation is also found in the B&W tests on burning Pitt-Consol LTC char in the cyclone.

In burning gases or pulverized solid fuels, the critical region is that where the flame stabilizes itself in its propagation against the oncoming unburned stream which is called the anchor zone of the flame. Here conditions must be relatively quiescent compared to the remainder of the flame or the flame is blown off and ignition lost. The higher the normal (nonturbulent) burning rate of a fuel, the less critical this region becomes, for at the higher burning rates, blowoff of the flame is less likely. Beyond the anchor zone, high turbulence is, of course, desirable and necessary to achieve high Btu output per unit volume.

What are the characteristics of char that require somewhat more severe conditions to stabilize the flame? The properties of an LTC char produced from a high volatile Pittsburgh seam coal are as follows:

	Coal	Char
Volatile matter	42.5	14.5
Fixed carbon	47.5	71.5
Ash	10.0	14.0
Btu/lb	13,200	12,250

The notable difference between the two fuels is the lower volatile content and the high fixed carbon content of the char. The coal, as a fuel, gives off large quantities of combustible gases at the relatively low temperature of 800 F which readily mix and burn with the ambient air at a rapid rate so that ignition in such a solid fuel is relatively no problem. In contrast the volatile matter of LTC char (chiefly hydrogen and methane) is not given off readily until a temperature several hundred degrees higher is reached. Ignition of char must, therefore, be achieved principally by oxygen transport to the particle surface, the same process by which coal particles are burned after they are devolatilized. Hence adequate rates of combustion to maintain ignition are obtained when the char particles are sufficiently fine and close together so the diffusion paths are short *and* if the temperature is sufficiently high so that reaction with the fine particles heats them rapidly. Particles in such a reaction also must be guarded from excessive heat losses by radiation. This is accomplished by providing hot walls to surround the flame.

Therefore we see that to maintain ignition or anchorage of a char flame at a given point in the burner requires adequate air preheat, high-particle cloud density, relatively fine particles, and radiation shielding. With these conditions fulfilled the flame stabilization is accomplished at a point where the stream velocity is relatively slow, as at the walls or entry cone of a cyclone. In addition, the normal burning velocity of char can be increased by providing an intense pilot flame of premixed gas and air which becomes the anchor point of the flame.

Studies of the burning velocity of char were made on a lab scale in Pitt-Consol laboratories using a 2-in-diam burner with a peripheral pilot flame of premixed natural gas and air to stabilize the flame. The combustion chamber (6 in. in diam made of firebrick) was heated to 1400 F prior to introducing the char. For experimental purposes the char used was ground to 70 per cent through 200 mesh. It was found that a stable conelike flame could be achieved in this small unit with as little as 1½ per cent Btu input via the pilot as natural gas, or other fuel. A larger jet-type burner would probably require as little as 0.1 per cent Btu input. The effect of preheat temperature and fuel concentration on the flame height (which is a function of the flame velocity) was correlated. The flame velocity is appreciably higher for the higher preheat temperature and also for the higher fuel concentration. In a like manner, coal flame stabilization is aided, however, milder conditions can be employed.

To sum up, we would like to say that burning of char and coal is much the same once flame stabilization is achieved. The conditions necessary for ignition are fulfilled in a cyclone-type burner. Char with fineness less than 15 per cent through 200 mesh has been burned successfully without the addition of auxiliary fuel. Rates of combustion were achieved such that the unit can be operated at full capacity just as can be done with coal.

Comment by J. J. Grob[4]

My discussion of this excellent paper, in the form of a question, is as follows:

In the operation of the cyclone furnace, with variable fuels and ash characteristics and particularly when recycling fly ash, I am interested in whether any problems are encountered due to carryover particles of molten fly ash into the outer furnace? The problems I have in mind are the possible glazing or coating of outer furnace water walls or other heat-transfer surfaces with consequent losses in exit-gas temperature, superheat temperatures or both? If this happens, my next question is as to the degree of rise in exit-gas temperature or drop in superheat and means for cleaning to restore normal conditions?

[1] Research Supervisor, Research and Development Division, Pittsburgh Consolidation Coal Company, Library, Pa.

[2] Research Chemist, Research and Development Division, Pittsburgh Consolidation Coal Company, Library, Pa.

[3] "Multifuel-Firing of Cyclone Furnaces," by G. A. Watts and W. L. Sage, MECHANICAL ENGINEERING, vol. 78, September, 1956, pp. 823–827.

[4] Chief Performance Engineer, mechanical engineering department, Consolidated Edison Company of New York, Inc., New York, N. Y. Mem. ASME.

Authors' Closure

We wish to thank Messers. Sylvander, Ziekle, and Grob for their comments.

In answer to Mr. Grob, the fouling of generating surfaces by slag is largely dependent on furnace design, the use that is made of cleaning equipment, and the composition of the slag; but not too much upon the quantity of slag.

Experience with flyash re-injection to cyclones has been limited to a number of tests at the Research Center and on one 400,000 lb/hr steam capacity commercial unit. No increase in fouling of boiler or superheater surfaces has been observed during periods of flyash re-injection; in fact, it seems to have been less. Measured dust loadings on these units show that more than 90 per cent of the re-injected flyash is retained in the cyclone. If the ash has the same composition or slagging properties as that from the fuel being fired, we would not expect any greater fouling of the heating surfaces.

W. L. Sage.[5]

Books Received in Library

Exploration for Nuclear Raw Materials. Edited By Robert D. Nininger. 1956, D. Van Nostrand Company, Inc., Princeton, N. J. 293 p., 6 × 9¼ in., bound. $7.50. Thirty-three papers from the International Conference on the Peaceful Uses of Atomic Energy are the basis of this volume, which is one of a series of presentations of significant material on selected subjects treated at the Conference. The contents of the papers have been edited and rearranged to provide a cohesive account of two major topics: The geology of uranium and thorium and prospecting techniques. Most of the chapters include lists of references.

Flow Measurement by the Differential-Pressure Method. Prepared by George Kent, Ltd., Luton, Bedfordshire, England. Second Edition, 1956. 136 p., 5½ × 8⅝ in., bound. 10s. This small book contains simplified orifice tables and related information useful to the oil-field engineer, to the engineer in testing equipment, and to the process engineer in measuring piped supplies of water, air, gas, or steam. Although the data apply mainly to ordinary straight iron pipes with nonpulsating flows and of the usual industrial size, one section of the book is devoted to flow under abnormal conditions. The last part of the book is a catalog of the products of the publisher.

Gmelins Handbuch der Anorganischen Chemie. System No. 28, Calcium, Part B, Section 1. System No. 60, Copper, Part A, Section 2. 8th edition, 1955, 1956, Verlag Chemie, Weinheim, Germany. 755 p., 264 p., 6⅜ × 10 in., paper DM 421.00, DM 147.00. The following two volumes of the new edition of this standard reference work provide an extensive compilation of technical information on their respective subjects: Number 28: Calcium. Part B-Section 1. Technology of calcium and its compounds. Number 60: Copper. Part A-Section 2. Chemistry and physics of elemental copper: preparation; physical properties; chemical and electrochemical behavior; physiological hazards; analysis and determination. Original references are cited for all data given. These volumes cover the literature through 1949, and in some cases up to 1954.

A Handbook on Belt Conveyer Design. Compiled in association with Hewitt-Robins, Inc., New York, N. Y., and published 1956 by the General Electric Company, Ltd., Erith, Kent, England. 148 p., 5¾ × 9¼ in., bound. 30s. Detailed explanations and calculations for the design of individual conveyers are given in this handbook. The first section of the book deals with the factors to be taken into account in the design of conveyers for specific purposes, and the following sections take up such essentials as idlers, drive equipment, trippers, brakes, and shaft design. Sample calculations for several types of conveyers are included, and tables of data are provided.

Heat Power Fundamentals. By Carroll M. Leonard and Vladimir L. Maleev. Second Edition 1956. Pitman Publishing Corporation, New York, N. Y. 527 p., 6 × 9¼ in., bound. $7. In addition to presenting the fundamentals of thermodynamics, this text deals with steam, internal-combustion, and gas-turbine power plants, and includes a chapter on mechanical refrigeration. A new feature of the present edition is the treatment of the problems of heat transfer in a separate chapter. Tables of properties of steam and air are appended.

Hütte. Volume 3: Bautechnik. 28th edition, 1956, Wilhelm Ernst und Sohn, Berlin. 1616 p., 4¾ × 7¼ in., bound. DM 42.00. The main topics dealt with in the present volume of this standard German handbook for engineers are statics; wood, steel, and concrete construction; water supply and sewage; heating and ventilating; construction machinery; city planning; dams; tunnels; foundations; bridges; and highways. In this edition, some textual revisions have been made, some new material is supplied in a supplementary section, and a new section covering prestressed concrete and compound construction has been added.

Induction Heating Practice. By D. Warburton-Brown. 1956, Philosophical Library, Inc., New York, N. Y. 192 p., 5⅞ × 9 in., bound. $10. The general principles and specific practical applications of induction soldering, brazing, and hardening are discussed, and detailed information is given on the design of coils, inductors, and handling fixtures. Factors to be considered in selecting the process are also treated, and one chapter is devoted to the design of components for production by the induction heating method.

Industrial Engineering Handbook. Edited by H. B. Maynard. First Edition, 1956. McGraw-Hill Book Company, Inc., New York, N. Y. Various paging, 6 × 9¼ in., bound. $17.50. This comprehensive reference book for practicing industrial engineers contains 58 chapters grouped in the following eight sections: the industrial engineering function; methods; work measurement; predetermined - elemental - time standards; wage payment; control procedures; plant facilities and design; and other aspects. The individual chapters, each prepared by an authority in the field covered, deal with a wide range of techniques and functions, including organizing for industrial engineering; process charts; curves and nomographs; planning and measuring maintenance and construction work; product classification, and the preparation of reports.

Introduction to Solid State Physics. By Charles Kittel. Second Edition, 1956. John Wiley and Sons, Inc., New York, N. Y. 617 p., 5¾ × 9¼ in., bound. $12. An account of such representative aspects of the physics of solids as crystal structure, thermal and dielectric properties of solids, the free electron and band theories of metals, paramagnetism, ferromagnetism, super-conductivity, and semiconductors. This edition provides fuller explanations of basic concepts than did the previous edition and includes new material on alloys, imperfections in solids, photoconductivity, and luminescence. The book is intended for scientists and engineers who may not have had formal courses in the subject, as well as for students of physics, chemistry, and engineering.

Kaltpressen und Kaltstauchen. By W. M. Missoshnikow and M. J. Grinberg. 1955, Verlag Technik Berlin, Germany. 336 p. 5¾ × 8¼ in., bound. DM 21. A German translation of a Russian book dealing with cold-pressing and cold-upsetting of metals. It describes the equipment, the materials and the processes used, with detailed treatment of the tools involved. There are also suggestions on planning a cold-pressing department in a manufacturing plant.

Latex; Natural and Synthetic. By Philip G. Cook. 1956, Reinhold Publishing Corporation, New York, N. Y. 231 p., 4⅝ × 7 in., bound. $3.50. One of a series of concise summaries of new processes, materials, or techniques, published to make information on recent developments readily available to engineers and technicians. The book deals with the production and modification of both neutral and synthetic types of latex, and their conversion into useful products. Vulcanization, compounding, processing, and testing are discussed, and methods of manufacture of various products—foams, footwear, molds, adhesives, etc.—are described.

Manganese Steel. Published for Hadfields Limited-Sheffield by Oliver and Boyd, Edinburgh, Scotland. 128 p., 5⅝ × 9 in., bound. 18s. A summary of present knowledge, covering historical background, manufacture and processing, metallography, properties, heat treatment, work-hardening, machining,

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[5] Research Engineer, The Babcock & Wilcox Company Research Center, Alliance, Ohio.

welding, influence of temperature on properties, and modifications in composition. Nonmagnetic steel for electrical purposes is briefly described, and industrial applications are noted.

MATERIALS OF ENGINEERING. By Carl A. Keyser. 1956, Prentice-Hall, Inc., Englewood Cliffs, N. J. 502 p., 5⅝ × 8⅝ in., bound. $8. Basic information on metals, inorganic nonmetallic materials, and organic materials, presented concisely and with emphasis on practical applications. About three-quarters of the book is devoted to metals, the remainder to such materials as clay, glass, gypsum, concrete, plastics, rubber, organic coatings, and wood.

MECHANICAL DESIGN FOR ELECTRONIC ENGINEERS. By R. H. Garner. 1956, D. Van Nostrand Company, Inc., Princeton, N. J. 223 p., 5½ × 8¾ in., bound. $5. A concise review of methods for the design and construction of rack systems, apparatus cabinets, chassis, panels, and other equipment, along with practical suggestions for sheet metalworking, finishing, soldering, brazing etc. Additional subjects treated include accessibility for servicing, ventilating and cooling, labeling of panels and cables, coil winding, printed circuits, and potting of components.

MECHANICAL DESIGN FOR ELECTRONICS PRODUCTION. By John M. Carroll. 1956, McGraw-Hill Book Company, Inc., New York, N. Y. 348 p., 6 × 9¼ in., bound. $6.50. Intended to meet the needs of electrical and mechanical engineers as well as those of electronic engineers, this book is a compendium of design methods, production processes, and manufacturing techniques used in electronic industries. The wide range of subjects covered includes space planning, chassis design, fabricating and finishing, shielding, potting, assembly methods, and cabinet construction. A chapter on environmental factors deals with design to withstand shock and vibration, extreme temperatures, explosive atmospheres, and other hazards. The book is based on a group of articles in the October, 1954, *Electronics* magazine.

MECHANICS OF THE ROLLER CHAIN DRIVE. By R. C. Binder with the collaboration of the Engineering Staff of the Diamond Chain Company. 1956, Prentice-Hall, Inc., Englewood Cliffs, N. J. 204 p., 5½ × 8½ in., bound. $5. This mathematical analysis of the dynamics and statistics of roller chains operating over sprockets provides a basis for developing the power capacity, or rating, of roller-chain drives. Among the factors analyzed are centrifugal force, tooth-pressure angle, roller velocity, sprocket velocity, chain-strand vibration, and the path of the chain strand. The last chapter is an analytical study of a simple type of roller chain drive, made in order to outline a general method for rating drive.

PRACTICAL PETROLEUM ENGINEERS' HANDBOOK. By Joseph Zaba and W. T. Doherty. Fourth Edition, 1956. Gulf Publishing Company, Houston, Texas. 818 p., 5⅝ × 8⅝ in., bound. $14. An extensive compilation of tables, charts, and formulas connected with drilling and production practice, including sufficient explanatory text material for practical use. There are also separate chapters on general engineering data. About 150 pages of new material have been added in this edition.

PROGRESS IN NUCLEAR ENERGY. Volume 1. Series 2, Reactors. Edited by R. A. Charpie and others. 1956, McGraw-Hill Book Company, Inc. New York, N. Y. 492 p., 6 × 9¼ in., bound. $14. The first five chapters of this review of the present state of reactor technology are summaries of the power-reactor programs in the United States, Canada, the United Kingdom, Europe, and the Soviet Union. The remaining six chapters deal with the Shippingport (Pa.) reactor; a prototype boiling water reactor; aqueous homogeneous power reactors; the graphite-moderated, gas-cooled pile; the sodium-cooled graphite reactor; and fast power reactors. A country-by-country list of existing and projected reactors is given at the end of the volume.

ASME Boiler and Pressure Vessel Code

Interpretations

THE Boiler and Pressure Vessel Committee meets regularly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th Street, New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

(The following Case Interpretations were formulated at the Committee meeting Nov. 2, 1956, and approved by the Board on Dec. 27, 1956.)

Annulment of Cases

The following cases are annulled:

Case Nos.	Reason for Annulment
1037-1	Lack of use
1153	Stress values are now included in Table P-7
1189	Essence of Case now included in Pars. H-31 and H-88
1203	Essence of Case now included in revisions to Pars. Q-6(a)(4), QN-6(a)(4), Q-8(c)(d), and QN-8(c)(d) and adoption of Figs. Q-8.1 and QN-8.1
1212	Essence of Case now included in Par. H-73(c)

Errata to Case No. 1188

(Special Ruling)

In the Inquiry, Chemical Requirements, add the word "max." after the designation of "2.00 Manganese, per cent."

Case No. 1064

(Special Ruling)

This case was formulated to permit the fabrication of heating boilers constructed from copper or copper-base alloys under the rules of the Low-Pressure Heating Boiler Code. However, notice of its annulment was published in the June, 1956, issue of MECHANICAL ENGINEERING. Subsequently, it has been learned that this Case is in demand and is being used by manufacturers; therefore, Case No. 1064 is reinstated. (NOTE: Due to the length of this Case, it is not reprinted, but copies can be purchased from the ASME Order Department.)

Case No. 1205-1

(Reopened) (Special Ruling)

In the Reply, omit the word "openings" in 3(a).

Add a new 3(c), reading as follows:

Only threaded openings in the shell portion not exceeding 2 in. pipe size and complying with the requirements of Par. UG-43(f). All openings shall be reinforced to satisfy the requirements of Par. UG-37. The provisions of Par. UG-36(c)(3)(b) shall not apply.

Change present 3(c) to 3(d).

Add a new paragraph 7(a) as follows:

The vessel has no stress raisers such as openings, welded attachments, or stamping on the shell portion.

Reletter present Pars. 7(a),(b),(c), and (d) to 7(b),(c),(d), and (e) respectively.

Case No. 1226-2

(Reopened) (Special Ruling)

In the Reply, revise the definition of Containment Vessels at the end of Case to read as follows:

Containment Vessels are those outer vessels which enclose the reactor vessel or portions of the primary coolant circuit or both. The containment vessels are not normally pressurized and are built to contain the lethal radioactive substances that may be released in case of an accident or failure of the reactor vessel or the primary coolant circuit or both.

Case No. 1227-1

(Reopened) (Special Ruling)

In the Reply, under Chemical Composition, revise the Columbium plus tantalum range to "0.15-0.45 per cent."

Case No. 1229

(Special Ruling)

Inquiry: May Leaded Nickel Bronze, Alloy 11A of ASTM Specification B 149-52 be used under the Code for the production of pressure castings for use at a maximum temperature of 300 F?

Reply: It is the opinion of the Committee that Alloy 11A of ASTM Specification B 149-52 may be used under the conditions described in the Inquiry provided the elongation in 2 in. is not less than 12 per cent and that it is not welded.

The allowable design stresses are:

Temperature, deg F	Stress, psi
Up to 100	6000
150	6000
200	5800
250	5500
300	5000

Case No. 1230

(Special Ruling)

Inquiry: Is it permissible, under the Code, to fabricate unfired pressure vessels of approved copper-base materials by brazing, provided the shells are of seamless pipe or tubing? If so, what special requirements would apply for brazing, head to shell joints, tube sheet to shell joints, tubes to tube sheets, and nozzle connections to heads or shells?

Reply: It is the opinion of the Committee that pending promulgation of definite rules for the qualification of brazing procedures, brazers, and brazing operators, brazing may be used to fabricate copper-base unfired pressure vessels under the following limits and requirements:

(1) *Service Conditions* Vessels fabricated under the requirements of this case shall be limited to a maximum allowable working pressure of 300 psi and to a maximum operating temperature of 200 F.

(2) *Material* The base materials shall be limited to the following:

Shell material: Red Brass, ASTM B 135-55, Alloy No. 1

Head and tube sheet material: Naval brass, SB-171

Tube material: Copper, SB-75

(3) *Design* All applicable design requirements of Section VIII of the Code shall be met including Part UB of Subsection B except as specifically modified herein. All details of design not specifically covered by existing Code rules shall be subject to the approval of the authorized inspector who will satisfy himself that such details of design will be as safe as those provided by the rules of the Code.

The allowable stress value for ASTM B 135, Alloy No. 1, shall be 8000 psi.

(4) *Brazing* (a) Brazing alloys shall be limited to ASME Specification SB-260, Alloys BAg-1 and BCuP-3. Brazing temperature ranges shall be within the practical fabrication range of the base materials used.

(b) Brazing fluxes shall be of suitable commercial grades and any change in composition of flux shall require requalification of the procedure.

(c) The brazing process shall be limited to torch brazing and insofar as practical shall be performed with the work in the flat position with the brazing alloy applied from the top side of the joint to provide for either horizontal or vertically downward flow of the brazing alloy. The brazing filler metal may be applied by face feeding or by the use of preplaced inserts.

(d) Types of joints shall be limited to the following:

Head to shell joints shall be of the lap type. The minimum lap shall be not less than four times the thickness of the thinner of the parts being joined.

Tube sheet or shell joints may be of the "Tee" type or of the "Rabbet" type as illustrated in Figs. 1 and 2. The minimum lap in a "Rabbet" type joint shall be at least four times the shell thickness except where the construction is considered as being fully stayed and the joint is a seal joint only, in which case the minimum lap may be no less than two times the shell thickness.

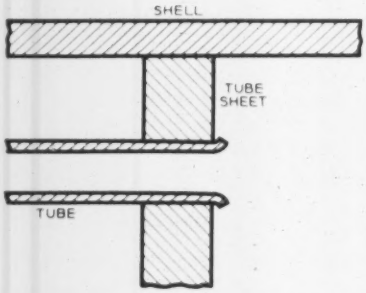


Fig. 1 "Tee" Joint

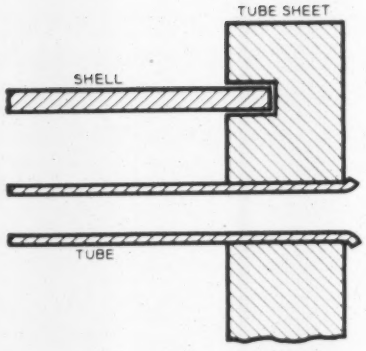


Fig. 2 "Rabbet" Joint

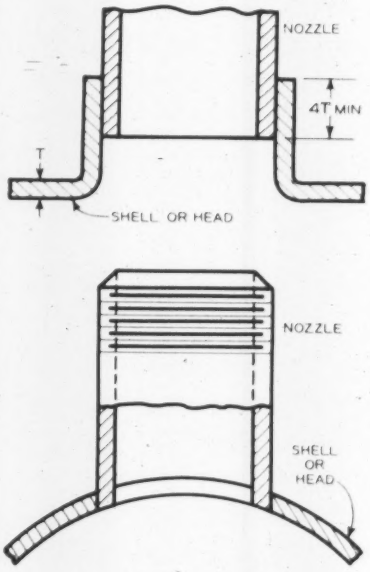


Fig. 3 Nozzle Attachments

Nozzle connections to the heads or shell may be made by a lap joint to an extruded neck in the head or shell as shown in Fig. 3 or by an insert fitting brazed in the opening in the shell or head. For the neck attachment the minimum lap shall be not less than four times the thickness of the shell or head. The insert nozzle attachment shall be limited to 3 in. nominal pipe size.

(e) Brazing techniques shall follow established good practice[1] and shall satisfy the authorized inspector.

[1] See AWS Brazing Manual.

(f) In the absence of specific rules governing the qualification of brazing procedures, brazers and brazing operators, the following requirements shall be complied with:

The brazing procedure shall be recorded in a form[2] and manner satisfactory to the authorized inspector, who shall satisfy himself that the brazing practiced during manufacture properly follows the recorded procedure.

In order to establish the adequacy of the brazing procedure the following tests shall be conducted for each type of joint, combination of materials and thicknesses encountered in actual manufacture:

For lap joints, two reduced-section tension tests, Fig. 4, and two "peel" tests, Fig. 5.

For rabbet joints, two reduced-section tension, Fig. 6, and two cross-section samples.

For all other types of joints two cross-section samples.

[2] The form for Recording Brazing Procedure as given in the AWS Brazing Manual is recommended for this purpose.

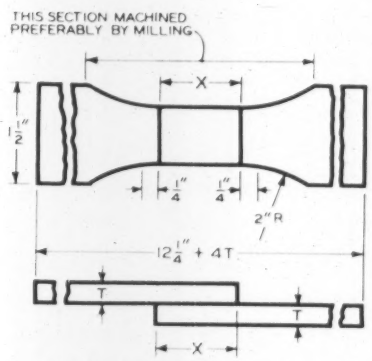


Fig. 4 Reduced-Section Tension Test Specimen for Lap Joints

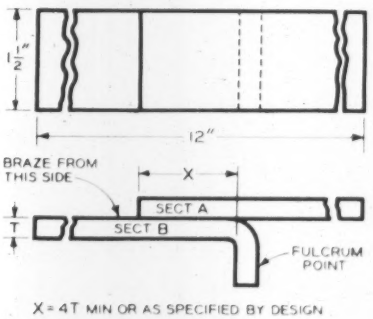


Fig. 5 Peel Test Specimen for Lap Joints

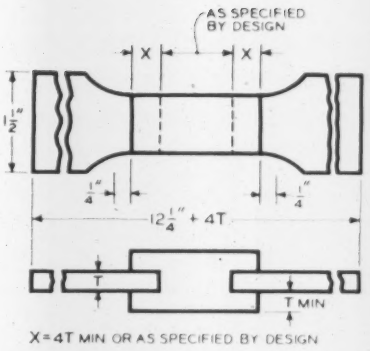


Fig. 6 Reduced-Section Tension Test Specimen for Rabbet Joints

The reduced-section tension specimens shall be ruptured under tensile load, using a suitable support fixture, if necessary. The tensile or shear stress shall be computed by dividing the maximum load at failure by the nominal cross-section area of the thinnest member comprising the joint.

The specimen shall have a minimum strength not less than the specified minimum tensile strength of the base material in the annealed condition or of the weaker of the two materials in the annealed condition if materials of different specified minimum tensile strengths are used.

The peel specimens shall be "peeled" or separated in a suitable manner so that the faying surfaces of the joint will be exposed. The separated surfaces shall show substantially complete penetration of filler metal from one edge to the other and the sum of the areas of inclusions or other defects shall not exceed 30 per cent of the area of the faying surfaces.

The cross-section specimens shall be dressed to smoothness and when examined under a magnifying glass shall exhibit substantially complete penetration of filler metal from one edge to the other. The total length of voids exposed by cross-sectioning shall not exceed 20 per cent of the exposed length of the braze.

In order to prove the ability of each individual brazer to follow the brazing procedure and to produce sound brazed joints, each brazer shall prepare a workmanship sample representative of the design details of each type of joint he will be called upon to braze in production.

The sample shall be sectioned and dressed to smoothness. When examined under a magnifying glass it shall exhibit substantially complete penetration of filler metal from one edge to the other and voids, if any, shall not exceed 20 per cent of the total length of the braze.

The authorized inspector may require retesting of the brazing procedure when there is any change in any detail of that procedure and he may require retesting of any individual brazer if he has reason to question his ability.

Case No. 1231

(Special Ruling)

Inquiry: Is it permissible in welded construction conforming to the requirements of Section VIII of the Code to use alloy steel plate conforming to the requirements of the following specification?

(1) *Scope:* This specification covers alloy-steel plates of flange quality intended particularly for use in welded pressure vessels. The maximum thickness shall be 0.58 in.

(2) *General Conditions for Delivery:* Material furnished under this specification shall conform to the applicable requirements of the current edition of the Tentative Specification for General Requirements for Delivery of Rolled Steel Plates of Flange and Firebox Qualities (SA-20), except as herein modified.

(3) *Process:* The steel shall be made by either or both of the following processes: open hearth or electric furnace.

(4) *Chemical Composition:* The steel shall conform to the chemical requirements prescribed in Table 1.

Table 1 Chemical Requirements

	Per Cent
Carbon, max	0.18
Manganese	0.50-1.00
Phosphorus, max	0.04
Sulfur, max	0.05
Silicon	0.50-0.90
Zirconium	0.03-0.15
Copper, max	0.25

(5) *Tensile Properties:* (*a*) The material as represented by the tension test specimens shall conform to the requirements as to tensile properties prescribed in Table 2.

Table 2 Tensile Requirements

Tensile strength, psi	75,000-90,000
Yield point, psi, min	50,000
Elongation in 8" min per cent	20

(*b*) For material under $^{5}/_{16}$ in. in thickness a deduction from the percentage of elongation specified in Table 2 of 1.25 per cent shall be made for each decrease of $^{1}/_{32}$ in. of the specified thickness below $^{5}/_{16}$ in.

(6) *Bending Properties:* The bend test specimen shall stand being bent cold (room temperature) through 180 deg without cracking on the outside of the

bent portion to an inside diameter equal to three times the thickness of the specimen.

(7) *Number of Tests* One tension test and one bend test shall be made from each flange steel plate as rolled.

NOTE: The term "plate as rolled" used here refers to the unit plate rolled from a slab or directly from an ingot in its relation to the location and number of specimens, not to its condition.

Reply: It is the opinion of the Committee that the steel specified in the inquiry may be used in the construction of welded unfired pressure vessels under the requirements of Section VIII of the Code provided the following additional requirements are complied with:

(1) The maximum nominal thickness of the head or shell plate shall be 0.58 in.

(2) The maximum operating temperature shall not exceed 650 F.

(3) The maximum allowable working stress shall be 18,750 psi.

(4) The qualification of the welding procedure and the welders shall conform to the requirements of Section IX. A separate welding procedure and performance qualification shall be made for this material.

Proposed Revisions and Addenda to Boiler and Pressure Vessel Code . . .

AS NEED arises, the Boiler and Pressure Vessel Committee entertains suggestions for revising its Code. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code.

Comments should be addressed to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th Street, New York 18, N. Y.

Material Specifications, 1956

ERRATA TO 1956 ADDENDA—On Table II, page 1, the yield strength value for Alloy 996A, Temper O, should be corrected from "22500" to read "2500."

The Boiler and Pressure Vessel Committee has adopted the revisions made by ASTM for inclusion in the following specifications with the exceptions as noted:

Ferritic Castings & Forgings

SA 95-44 Delete in its entirety

Ferritic Plates

SA 6-56T	SA 357-56T
SA 7-56T	SA 387-56T

SA 301 Delete in its entirety

Stainless Steel

SA 182-56T	SA 249-56T
SA 193-56T	SA 312-56T
SA 194-56T	SA 320-56T
SA 213-56T	SA 376-56T

Low-Pressure Heating Boilers, 1956

PAR. H-68 Add the following paragraphs (f) and (g):

(f) When a boiler unit is furnished by one manufacturer and is not assembled and subjected to hydrostatic test prior to shipment, the manufacturer of the boiler unit shall compile a Manufacturer's Data Report Form P-2 recording all items of the complete boiler unit.

The Manufacturers' Data Report shall be properly executed by the manufacturer and the authorized inspector, who shall sign the certificate of shop inspection certifying that each enumerated item which has been inspected at the shop conforms to the requirements of the ASME Code. The manufacturer in signing each data report shall state under his signature the expiration date on the Certificate of Authorization to use the symbol.

Proper stamping as required by Par. H-68(b) shall be applied at the shop and the data sheets shall be signed by the same or different inspectors who shall indicate the portions of the inspections made at the shop and in the field.

(g) The assembly of any parts or subassemblies of the unit that requires welding shall be made by one possessing a heating boiler stamp, or an assembly stamp. The welding of any parts or subassemblies during field assembly shall be done only by persons who meet the requirements of Par. H-75. When the assembly is made by anyone other than the manufacturer of the boiler unit, the data report sheet properly executed in accordance with Par. H-68(f) shall be forwarded to the assembler who shall be responsible for the proper handling of the data report and who shall fill in such items as are not filled in at the shop, and sign the data sheet as the "assembler" or "assembling organization" instead of "manufacturer." He shall also append, above his signature, the statement "We certify that the field assembly of all parts conforms with the requirements of the ASME Boiler and Pressure Vessel Code."

The field inspection shall be made by an authorized inspector (as defined in Par. H-68(a)) and the inspector shall make such inspections as he believes are needed to enable him to certify that the boiler has been constructed in accordance with the Code. Data reports, together with the inspector's own inspection, shall be the authority to sign the certificate of field inspection.

The assembler's stamp, together with the assembler's name or an acceptable abbreviation, shall be applied in the field on the boiler near the stamping called for in Par. H-68(b), when authorized by the field inspector.

The certificate of field inspection on the data report shall be executed by the authorized inspector. The assembler or assembling organization shall forward the data reports to the proper authorities.

Unfired Pressure Vessels, 1956

PAR. UHA-32(c) Revise to read:

(c) Stress-relief or other heat-treatment of vessels constructed of materials conforming to Type 405 welded with electrodes that produce an austenitic chromium-nickel alloy steel weld deposit is neither required nor prohibited.

TABLE UNF-23 Delete reference to specification SB-211, Grades GS11A, CG42A, and CS41A stress values under the heading "Bars, Rods and Shapes."

ANNOUNCEMENT

FIGS. UNF-28.17 AND UNF-28.18 Under Charts for External Pressure add Figs. UNF-28.17—Chart for Determining Shell Thickness of Cylindrical and Spherical Vessels Under External Pressure When Constructed of Aluminum Alloy 996A-O, and UNF-28.18—Chart for Determining Shell Thickness of Cylindrical and Spherical Vessels Under External Pressure When Constructed of Aluminum Alloy GR20A-O or GR20A-H112. (NOTE: These figures are available from the Secretary of the ASME Boiler and Pressure Vessel Committee, 29 West 39th St., New York 18, N. Y.)

Welding Qualifications, 1956

TABLE Q-11.1 Under classification P-Numbers 3 and 4, delete the word "low" before the word "alloy" in the heading.

TABLE Q-11.1 Under classification P-Number 5, delete the word "medium" in the heading.

TABLE Q-11.1 Under classification P-Numbers 9 and 10, add as a heading "Nickel Alloy Steels."

Roundup

Of Current Engineering Events, News, and Comment

E. S. Newman, News Editor

AAAS Acts on Resolution Submitted by Committee on Social Aspects of Science

Engineers and surgeons discuss co-operation at Gratz luncheon

In connection with the program arranged by Section M—Engineering of the American Association for the Advancement of Science during the 123rd annual meeting held in New York, N. Y., Dec. 26-30, 1956, Charles Murray Gratz, M.D., of New York, N. Y., was host at a luncheon of representatives of the medical and engineering professions. The luncheon commemorated 21 years of activity by Dr. Gratz in the field of biomechanics, and the publication in Mechanical Engineering, April, 1935, of the results of his experiments in the measurement of the tensile strength and elastic limit of the fibrous tissues of living bodies.

In the experiments reported in 1935 Dr. Gratz co-operated with the late Prof. George B. Karelitz of the department of mechanical engineering at Columbia, who adapted the well-known techniques used in materials testing to the fibrous material under investigation. As a result of this noteworthy co-operation of the medical and engineering professions, Dr. Gratz was able to state that the fibrous connective tissues of the human body will resist a stress of 7000 psi without injury when properly positioned. His studies of fibrous tissues have been termed "classical" by the eminent orthopedist, Dr. Arthur Steindler.

In the two decades that have elapsed since the result of his studies were announced, Dr. Gratz has written extensively of their clinical applications in his own practice as an orthopedic surgeon, and his contributions have been acknowledged and put to use by many members of his profession. In the field of engineering, attention has been focused on the concept of the machine and the man as a single unit to be taken into consideration in design, particularly in respect to structures such as airplanes and automobiles in which protection of the human cargo against injury or death as a result of accidental crash is of paramount importance.

Present at the luncheon were representatives of the AAAS, ASME, and a number of medical societies. Opportunity was afforded for comments by engineers and doctors, and the hope was expressed that the future would bring about increasing co-operation between the two professions for the benefit of the public welfare.

After the luncheon Dr. Gratz addressed a session of Section M on the subject, "Biomechanics in Crash Mortality: The Surgical Approach Co-ordinating Man's Built-In Defenses."

AAAS Engineering Program

Trends in the design and evaluation of aids for control of man's environment were discussed in three AAAS Section M sessions December 26 and 27. Contributors discussed first the physical and mental abilities of normal man as a background for further analysis of machines, instruments, and computers for extending these abilities. Considered broadly, all sorts of tools and power equipment are "prosthetic devices" which either help unaided man or amplify his muscle power to aid in the control of his environment. The hammer hits harder without hurting than the clenched fist, the bicycle and especially the automobile are faster than running, and the airplane even allows man to fly, an accomplishment which is not merely an extension of his own powers but a new dimension of activity.

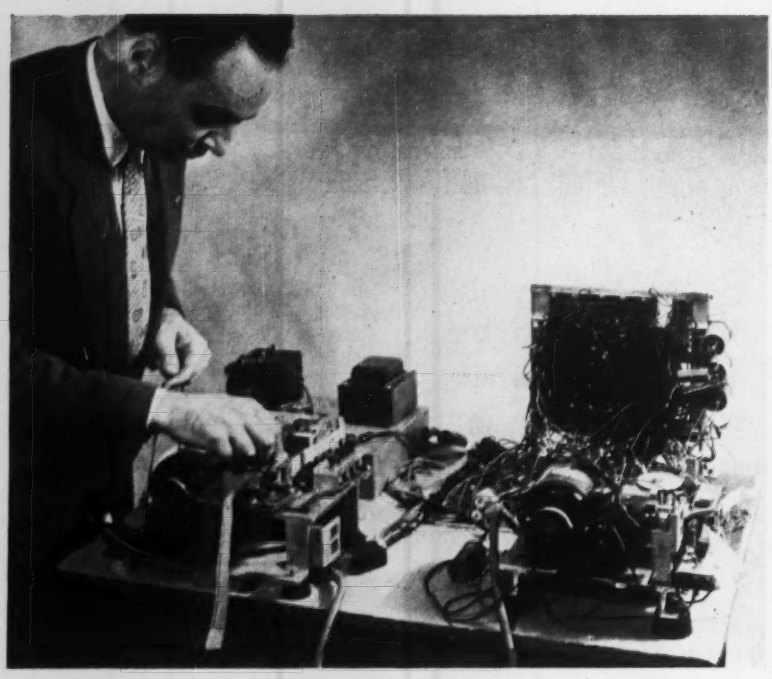
The common shovel, controlled by legs and back as well as arms, permits man to apply more of his own muscular efforts than the curved palms of the bare hands. The hand-operated windlass and crane are still more effective yet more complex. Finally, power shovels allow almost unlimited digging ability under control of a single operator.

In the sensory field we take for granted the telescope and the optical microscope to amplify vision as well as many forms of artificial illumination, from firelight to electric lamps, to increase brightness. In recent years the television set has become routine. The megaphone was better than cupped hands, but we now take for granted the far more useful telephone and rádio.

To aid in counting, fingers, scratches in the dirt, pebbles and beads, and finally pencil and paper were long used. Gradually more complicated forms of mathematics developed, still using these simple tools. The slide rule, increasingly sophisticated desk calculators, and great computers make possible more elaborate engineering and business computations. Clay tablets, chiseled stone, manuscripts, and books served as memory aids not only from one generation to another but in most cases for short-term memory of steps in computation.

Instruments first indicated, then recorded, and now can supply computed results. The instruments increasingly are used in feedback loops to regulate their own systems, extending from thermostats to complicated controls of oil refineries, chemical plants, and the booming field of automation of industry and business.

Many of the tools used as a convenience by normal persons are essential for those millions in this country alone who have some physical handicap. The elevator not merely makes possible tall buildings and high values for real estate but, almost accidentally, lengthens and brightens the life of the elderly, the person with heart disease, or the orthopedically handicapped. The automatic transmission is a luxury for the normal driver of an automobile, a convenience for the driver of a large bus, but the passport to simple transportation for the amputee and the polio. Many common kitchen tools help handicapped housekeepers. The jeweler and the machine-shop inspector rely on bright light and magnifying glasses to make possible more pre-



Loading IBM tape punch on TTS to Braille Translator as aid to blind

cise work on ever-finer mechanisms, but these aids are essential for a large share of the legally blind who fortunately retain some partial vision.

Still other and more specialized prostheses and sensory aids help the amputee, the wearer of braces or orthopedic shoes, the totally blind, and the hard of hearing. Unlike the elevator or the simple kitchen tool, such specialized devices as artificial limbs and braces are custom-fitted to individual users. Since fortunately a relatively small but widely scattered fraction of the population needs such help, the industry supplying artificial limbs and braces has consisted of small shops. Necessarily, therefore, the very extensive research program begun moret han a decade ago has been financed by the Government, co-ordinated by the National Research Council, and conducted in university and other private laboratories as well as those of the Army, Navy, and Veterans Administration. The limb industry, now growing toward a prosthetics profession, has been represented on committees co-ordinating this program and has participated vigorously in the schools which have made research results available to prosthetic clinic teams composed of doctor, therapist, and prosthetist, plus other specialists as needed.

Because the Artificial Limb Program has borrowed heavily from many disciplines, some of the instrumentation developed and the biomechanical methods for evaluating activities of amputees with their prostheses were reported in the Symposium on Aids for Environmental Control. Possibly some may be useful in evaluating the man-machine combinations involving normal persons and their tools.

In the second session the important problem of accidents—almost exclusively the result of man's thoughtless *misuse* of his powerful tools—were analyzed from the biomechanical standpoint by one of the pioneers of the field. Two papers on the major forms of computers, sometimes called "giant brains" but really only tools, discussed the vast implications of extension and amplification of man's computing ability. Improvements in speed, accuracy, and sheer magnitude make practical entirely new levels of calculation. Proper control of computers involves communication, so there arise specialized problems of matching the machine to the user on the intellectual rather than the physical level, and of translation between human and machine languages.

In the third and final session on Thursday, December 27, the broad problem of translation was considered further. The first example is the apparently simple case of translation from a six-hole code punched into paper tape, used in the printing industry, into another six-hole code representing braille, as an aid to the blind. The direct translation of letters is indeed easy, but some of the problems with capitals, shift keys, and punctuation foreshadow in miniature some of the difficulties in grammar, variation in numbers of words to express an idea, and semantic implications encountered in mechanical translation between human languages. Later speakers analyzed progress in mechanical translation of Russian and German into English.

A fascinating development in the last two decades has been the growing understanding of speech. Important progress has been made in compressing speech into telegraph-like signals for easier and more economical transmission, then reconstituting it into recognizable speech at the other end. The first or analytical step shows possibilities for construction of additional machines "recognizing" elements of speech and hence obeying spoken commands. The second step, synthesis, will be particularly important not only in speech compression but in attempts to build true reading machines for the blind.

Even persons with the highest physical and mental abilities, but speaking different languages, may have difficulty in working with each other. Thus breaking of the language barriers on a vast, automatic, and hence economical scale, as discussed by the last two speakers, is important for the best control of man's environment for the welfare of all humanity.

Social Aspects of Science Committee Report to AAAS Council

Following is the report of the Committee on the Social Aspects of Science that was submitted to the AAAS Council. The report was prepared as a sample of the problem of the impact of science upon society, which scientific advances have raised.

I Introduction

The Council of the AAAS at its 1955 meeting [in Atlanta, Ga.] resolved to establish an "Interim Committee on the Social Aspects of Science." During the past year this committeee has made a

preliminary review of the present state of science in the United States, and its relation to social forces and issues.

The committee found that even a cursory examination of this question leads to a most serious conclusion: That there is an impending crisis in the relationships between science and American society. This crisis is being generated by a basic disparity: At a time when decisive economic, political, and social processes have become profoundly dependent upon science, the discipline has failed to attain its appropriate place in the management of public affairs.

The committee believes that this question demands the most urgent attention of the AAAS and of scientists generally. The purpose of the present report is to bring this matter to the notice of the AAAS in the hope that the Council will see fit to undertake a program of study and action on this problem. Such an undertaking would come at a most opportune time. We are at the start of a period in which science holds the promise of making unprecedented improvements in the condition of human life. Any action taken now to assist the orderly growth and beneficial use of science will be of lasting significance.

II The New Scientific Revolution

A cursory examination shows that society has become far more dependent upon science than ever before:

1 *The accelerated growth of scientific activity*

The volume of scientific research and development conducted in this country has been increasing at an astonishing rate. In 1930, expenditures for science were estimated at $166 million; in 1953 the amount was more than $5 billion. Allowing for the change in the value of the dollar this represents approximately a 15-fold increase in research expenditures over the 23-year period. The number of active scientists in the United States in 1930 was 46,000; the present number is probably about 250,000. All estimates of future needs for scientific research and personnel indicate that this growth will continue at an accelerated pace. This rate of growth sets scientific activity apart as the second most rapidly expanding sector of our social structure, military activities being first.

2 *The increased use of scientific knowledge*

It is characteristic of the present era that the previously formidable gap between scientific knowledge and its application to practical problems has become considerably reduced. It is now a commonplace that calculations based on physical theory move quickly from the scientist's laboratory across the engineer's drafting board and on to actual industrial production. Since 1940, we have experienced a series of classic examples of almost immediate conversion of a scientific advance to a process of large practical impact upon society: antibiotics, synthetic polymers, nuclear energy, transistor electronics, microwave techniques, electronic computers. The greatly narrowed gap between laboratory and factory results from a distinctively new role of research in industry. Scientific investigations were previously regarded by industry as a kind of exotic garden to be cultivated in the hope of producing an occasional rare fruit. In contrast, research has now become a deliberate instrument of industrial development; scientific investigations are consciously undertaken as a means of achieving desired economic gains, or as in several notable industrial laboratories, for the purpose of contributing to our fund of basic scientific knowledge.

Recent advances in science have also created completely new industries. Four major industries: chemical, electronic, nuclear energy, and pharmaceutical represent direct extensions of laboratory experience to an industrial scale. This type of direct transformation of scientific experience to industrial operation is probably unique in human history. Earlier industrial developments were based more on empirical experience than on laboratory science.

III The Social Position of Science

Science is but one sector of our culture. It is one of the institutions of society, and to a considerable degree society itself governs the development of science. In the present situation, social forces influence the development of science in the following key ways:

1 *The social demand for technological advances*

From the evidence already cited it is clear that there is a strong social demand for at least some kind of scientific progress. The fact that industry has made unprecedented investments in research is practical evidence that this type of scientific work is seen as a desirable activity by industrial managers. Government scientific activity, which perhaps reflects a wider range of social forces, has also been very intense in the past 20 years. Accelerated support for scientific research is evident from the increased scale of military research, the growing activities of the National Science Foundation, the greatly increased support for medical research by the National Institutes of Health, and the increasing share of philanthropic funds from private agencies now devoted to research on health and social problems.

The following generalizations may be made concerning the distribution of the enhanced research support now enjoyed by American science:

(*a*) The major part of research support goes into applied research and development rather than basic science. In industrial research the ratio is about 97:3, in universities about 50:50; in federal agencies (including support for research done elsewhere) about 90:10.

(*b*) Support is heavily slanted toward physical sciences. In 1954, federal research support was divided as follows: physical sciences, 87 per cent; biological sciences, 11 per cent; social sciences, 2 per cent. Industrial research is at least as heavily weighted in this direction.

(*c*) At present a very large part of our total research activities is for military purposes. Of the estimated federal expenditures for research in 1957 ($2.5 billion), about 84 per cent is earmarked for matters related to national security.

(*d*) Colleges and universities, which are the site of much of our basic research activities have become dependent on federal funds for the greater portion of their research support (60–70 per cent) in 1954.

Some of the effects of these factors upon the character of scientific research are discussed in Section IV which follows.

2 *Public interest in science*

There are indications that the public interest in science is not commensurate with the important role of science in society.

(*a*) *The shortage of scientific personnel.*

We face a major crisis with respect to present and future shortages of scientific personnel. In effect, this means that the social environment in the United States does not elicit a maximum interest in science on the part of those individuals who have the capability of doing scientific work, or that our social organization does not permit them to receive the necessary training. This problem is closely connected with the more general question of the present state of public education in the United States. The content of public education has been subjected to a good deal of criticism recently, especially with regard to science and mathe-

matics. Many scientists feel that an official state requirement for graduation from high school which calls for one year of "general" mathematics and for one year of "general" science cannot be regarded as proper recognition of the importance of science.

(b) Attitudes toward scientific work.

To some degree the foregoing difficulties reflect a broader problem, i.e., a traditional disregard for abstract thinking. More than a century ago De Tocqueville observed "Hardly anyone in the United States devotes himself to the theoretical and abstract portion of human knowledge." He said, the immediately practical aspects of life, were, however, fully appreciated. The same generalization appears to be true today. So-called practical men of public affairs and business frequently disregard the advice of scientists and prefer instead to rely on "common sense," but the latter is often construed to mean what Einstein has called "a deposit of prejudices laid down in the mind prior to the age of 18." This problem, particularly as it relates to a lack of interest in scientific careers, has attracted considerable attention of late. Recent surveys indicate that the general attitude exemplified by popular epithets such as "egg-heads" and "long-hairs" is well rooted in the opinions of young people.

(c) Science in the public press, and other media.

By all standards, science receives an unduly small share of the budget of newspaper space or broadcasting time. The number of books and magazines devoted to disseminating public information about science is correspondingly small. The immediate reasons for this state of affairs are manifold. It is clear, however, that the situation reflects a rather low level of interest in science on the part of the public, or of those who attempt to judge the public mind for purposes of directing the media of information.

IV The Internal Situation of Science

How has its recently accelerated rate of growth, and the general nature of the social influences upon it affected the character of American science? Some brief and approximate answers may be made:

1 Unbalanced growth

The growth of our scientific organization has not been an orderly process. Growth has been based less on internal needs of science than on the interest of external agencies in possible practical results. In a sense, the speed and direction of the development of science has been determined by the users of science rather than the practitioners of science.

Agencies which use scientific knowledge (e.g., industrial management, military establishments, medical agencies) have undertaken to encourage, and pay for, scientific research of a sort which seems to promise information that might be useful to their own specific purposes. The disproportionate growth of the physical sciences as compared with biological and social sciences, to some degree reflects the interests and superior financial resources of the industrial and military agencies that support science.

The effects of this unbalanced development are already being felt. Generally speaking, we sometimes find ourselves embarking upon new ventures, based upon advances in chemistry and physics, before we are adequately informed about their consequences on life, or on social processes. Some of the resultant difficulties which we have already made for ourselves are described in Section V of this report.

It should be recalled that this unbalanced growth takes place within the frame-work of a shortage of personnel. This situation has very naturally given rise to a somewhat disorganized competition for students, which further accentuates the disparate pattern of development of the various sciences.

2 Inadequate progress in basic research

It is well known that the creative source of all technological advance is the free inquiry into natural phenomena that we call basic or "pure" science. However, as already indicated, the great bulk of our present research activities represents the development of practical applications of the knowledge generated by previous advances in pure science. It has been pointed out repeatedly that many of our current technological advances are based on the application of accumulated basic knowledge which is perhaps 20 to 30 years old. The progress of basic science does not appear to be keeping pace with the development of applied science. Some observers even feel that there has been an absolute decline in the amount of highly creative research of the type that leads to major advances in our knowledge of nature. They point out that our present understanding of the structure of atoms and molecules, and of the behavior of living cells goes back to great illuminating propositions that are 25 or more years old.

3 Difficulties in scientific communication

New information is the major goal of scientific research, and communication of information is vital for all scientific progress. However, the rapid, rather disordered growth of science has placed a severe strain on the channels of scientific communication:

(a) Communication among the divisions of science.

The problem of adequate dissemination of the results of current research has become a matter of great concern. The growth of our research establishment, and the resulting increase in the numbers of scientific communications have made the problem of "keeping up with the literature" quite serious. It is now widely recognized by scientists that the existing system of publication and distribution does not fill their needs. Published articles and monographs have not kept up with the current knowledge in many fields. The number of journals is insufficient (publication delays of one year are common) and methods of abstracting, indexing, and reviewing are inadequate.

It is becoming rapidly more difficult for scientists to find out what their colleagues know. The situation is particularly bad with respect to articles printed in foreign languages (Russian, especially) which investigators are too frequently incapable of reading.

Some observers have already urged the establishment of scientific information centers from which subscribers could receive transmitted reproductions or teletyped abstracts obtained by electronic scanning devices. Such centers would require government investment of about $150 million. That proposals of this magnitude are under current discussion is an indication of the severity of this problem.

Proper communication among scientists is not, however, merely a matter of developing proper recording, cataloging, and searching devices. Face-to-face meetings, which bridge the barriers of specialization, are an obvious necessity for the ordered growth of human knowledge. There is a widespread feeling among scientists that scientific meetings which bring together investigators from different fields of science are a necessity. But, with some distinguished exceptions, such meetings have been difficult to establish thus far.

(b) Imposed restrictions of free communication.

Although government support has been a major source of recent scientific growth it has been accompanied by influences which are in some respects inimicable to basic needs of science. Complete freedom of communication regardless of

national boundaries is an essential aspect of science; nevertheless, along with government support American science has been burdened with practices that restrict the free flow of information.

The interchange of scientific information is sometimes restricted unduly by the overclassification of data that affects national security. It must be acknowledged that at certain times, and with certain types of data, restriction of exchange of information is necessary so long as scientific progress continues to have military activity as one of its chief values. The immediate problem is to limit such restrictions to a minimal area. The ultimate problem is to free society as a whole and thereby science itself from the tyranny of war.

Not all artificially imposed restrictions on communication are due to government requirements. There is an understandable tendency on the part of industry to protect its investment in research by restricting distribution of its results. As a greater share of research is taken on by industry, especially in those areas where expensive, complex operations are involved, this problem will become of greater significance. It is ironical to note that a recent Conference on the Practical Utilization of Recorded Knowledge—Present and Future (at Western Reserve University, January, 1956) which devoted a good deal of attention to the problem of improved dissemination of knowledge, found it necessary to hold part of its deliberations behind closed doors, and to refrain from publicizing the full record of these "confidential" sessions (*American Scientist*, April, 1956).

V Major Social Issues of Scientific Origin: Signs of Trouble

The beneficial and orderly development and use of science calls for a harmonious interaction between science and the social forces which influence it. One way to measure the success of this interaction is to determine how well we have solved those social issues which are most closely related to scientific or technological knowledge.

Most of our successes are self-evident. Scientific knowledge is being applied to the development of a new industrial system capable of greatly increasing, in both quantity and quality, the total wealth of man. We are creating a remarkable establishment for medical and related research, which has given us mastery of many human ills, and has prolonged the span of life.

Nevertheless, scientific problems which influence social processes have become an arena of serious difficulties. In some situations our enhanced ability to control nature has gone awry and threatens serious trouble. Some examples follow:

1 *Radiation dangers*

It need hardly be pointed out at this time that the difficulties created by the dispersion of radioactive materials from nuclear weapons have caused considerable concern in this country and throughout the world. Regardless of one's attitude toward the necessity of setting off nuclear explosions for testing purposes, there is considerable evidence that this aspect of human control over nature is a potential danger to life. The recent controversy over the immediate significance of this problem shows that we have not yet developed methods for the orderly determination of the facts, in an area in which such facts may influence the health of the whole population of the Earth.

2 *Food additives*

The enormous growth of industry based on organic synthesis coupled with the already mentioned tendency toward rapid exploitation of scientific knowledge has resulted in a great increase in the number of man-made compounds now used in foods or otherwise ingested or absorbed by humans. The period of use of many of these substances has been rather short, and possible undesirable long-range biological effects have not yet had time to appear.

Laboratory methods for studying delayed biological effects, such as carcinogenicity are unfortunately difficult to manage, and equivocal in interpretation. Consequently the establishment of certification procedures which might assure the public that a given additive is harmless is a most difficult matter, which has been the subject of considerable discussion and controversy. Nevertheless, additives are in use, and the problem of making a reasonable determination of their safety needs to be faced.

A parallel situation exists in connection with the health hazards that arise from the dissemination of fumes, smogs, and dusts by industrial plants, and from automotive and other combustion processes. The harmful biological effects of these agents usually appear a long time after the commercial usefulness of the process is established and large-scale operations are in effect. By then remedial procedures are very difficult to carry out.

In these cases the use of substances resulting from scientific advance has already outstripped the base provided by our scientific knowledge. Information on the biological effects of a new substance is acquired at a very much slower pace than the rate at which new substances are made or put into use. It is probably inevitable that biological research will move more slowly than either chemistry or physics, but it should be expected, therefore, that we would put correspondingly more effort into research on biological phenomena. The opposite is the case. Less than about 10 per cent of our total research expenditure goes into biology and medicine.

3 *Natural resources*

The natural resources contained in the crust of the Earth comprise the major source of our wealth and it is a matter of concern that they be properly used. The natural laws which regulate the character and behavior of these resources lie within the domain of the various sciences. However, social decisions actually control what is done with our resources. It has been pointed out by Paul B. Sears, president of AAAS, that these decisions are rarely in the hands of scientists. Under these circumstances large-scale changes in our natural resources have occurred without proper consideration for the consequences which might be expected from a knowledge of natural laws.

An illuminating example cited by Dr. Sears is the recent flood disaster in New England. He points out that the widespread damage caused by these floods was a direct consequence of the unplanned crowding of housing areas into the river flood-plains. This was a failure to recognize and act upon physical events easily foreseeable from a relatively simple knowledge of the landscape. The declining water-table caused by irrigation practices illustrates a similar disregard for natural laws. In these, and more complex instances, the harmful outcomes of the given practice can be predicted by appropriate technical analysis. The failure to do so is, however, a social issue and Dr. Sears sees "little prospect of permanent relief unless we can establish among the American public and its political leaders a higher standard of scientific literacy than now obtains."

These examples show that social factors condition the use to which scientific knowledge is put. Perhaps the most striking example of this phenomenon is modern warfare, which represents a social decision to use the power of scientific knowledge for purposes of destruction and death.

VI Some Conclusions

The present state of science, and its relation to the social structure of which it

is a part, is characterized by the following general features:

1 We are witnessing an unprecedented growth in the scale and intensity of scientific work. Research has placed in human hands, the power to influence the life of every person, in every part of the Earth.

2 This growth has been stimulated by an intense demand for the practical products of research, especially for military and industrial use. Agencies which use the products of research are willing to provide financial support and other forms of encouragement for science, but show a natural tendency to favor those fields and aspects of science which most nearly relate to their needs.

3 The public interest in, and understanding of science, is not commensurate with the importance that science has attained in our social structure. It cannot be said that society provides good conditions for the proper growth of science. The effort to explain the nature of science to the public is slight compared with the public attention now given to other less consequential areas of human activity. Interest in science as a career is so restricted as to cause a serious and worsening personnel situation.

4 For reasons such as those just cited, science is experiencing a period of rapid but rather unbalanced growth. Basic research, which is the ultimate source of the practical results so much in demand, is poorly supported, and in the view of some observers lacking in vigor and quality. Areas more remotely connected with industrial and military applications, such as biology and the social sciences, are also not being adequately supported. The present period of rapid, unplanned growth in research activities is precipitating critical difficulties in connection with the dissemination and analysis of scientific information.

5 The growth of science, and the great enhancement of the degree of control which we now exert over nature have given rise to new social practices, of great scope and influence, which make use of new scientific knowledge. While this advance of science has greatly improved the condition of human life, it has also generated new hazards of unprecedented magnitude. These include: the dangers to life from widely disseminated radiation, the burden of man-made chemicals, fumes and smogs of unknown biological effect which we now absorb, large-scale deterioration of our natural resources, and the potential of totally destructive war. The determination that scientific knowledge is to be used for human good, or for purposes of destruction is in the control of social agencies. For such decisions, these agencies and ultimately the people themselves, need to be aware of the facts and the probable consequences of action. Here scientists can play a decisive role; they can bring the facts and their estimates of the results of proposed actions before the people.

VII The Need for Action: The Role of the Organizations of Science

This appears to be a critical time for review of the general state of science and its relation to society. We are now in the midst of a new and unprecedented scientific revolution which promises to bring about profound changes in the condition of human life. The forces and processes now coming under human control are beginning to match in size and intensity those of nature itself, and our total environment is now subject to human influence. In this situation it becomes imperative to determine that these new powers shall be used for the maximum human good, for if the benefits to be derived from them are great, the possibility of harm is correspondingly serious.

As scientists we are particularly concerned with determining how we should meet this situation, both as individuals, and through our organizations. In marked contrasts to other associations, scientific societies seldom consider the social and economic position of their group. Action taken on social problems with a scientific or technological base is sporadic and usually forced. Yet the democratic system is operated to a considerable extent under stimulus from groups, each representing the views and interests of its members.

Business and labor are not backward in presenting their opinions on social questions that affect them. They make sure that in the final decision their views have been considered. There are many who think that the viewpoint of scientists should also be stated publicly. In fact, if others express their opinions and scientists do not, a distorted picture will be presented, a picture in which the importance of science will be lacking and the democratic process will become to that extent unrepresentative.

The need for action is serious and immediate. Consider, for example, the situation relating to the biological hazards of radiation. It is now six months since the radiation committees of the National Academy of Sciences issued a report that called for a series of immediate actions including, among others:

1 The institution of a national system of radiation exposure record-keeping for all individuals.

2 Vigorous action to reduce medical exposure to x rays.

3 Establishment of a national agency to regulate disposal of radioactive wastes.

4 Establishment of an international program of control and study of radioactive pollution of the oceans.

5 Considerable relaxation of secrecy about dissemination of radioactivity.

In addition, the committees pointed out that "The development of atomic energy is a matter for careful integrated planning. A large part of the material that is needed to make intelligent plans is not yet at hand. There is not much time left to acquire it."

There is no evidence that these urgent pleas for action have yet met with any significant response. Clearly, this is a matter that requires the persistent attention of all scientists. It exemplifies the pressing need that scientists concern themselves with social action.

In this situation, the AAAS carries a special responsibility. As one of our past presidents, Warren Weaver, has said:

Resolution Submitted by the Council "Interim Committee on the Social Aspects of Science"

WHEREAS one of the purposes of the AAAS is "to improve the effectiveness of science in the promotion of human welfare, and to increase public understanding and appreciation of the importance and promise of the methods of science in human progress," and

WHEREAS the present rapid advance of science is accompanied by social problems of unprecedented magnitude that affect human welfare;

THEREFORE BE IT RESOLVED that in recognition of the responsibility of scientists to participate in deliberations regarding the use made of new scientific knowledge, the council of the AAAS authorizes the President to continue the work of this committee by appointing an enlarged group for the purpose of defining the problem, assembling the relevant facts and suggesting a practical program, this report to be submitted to the AAAS Board, to implement the objectives of the AAAS in this regard.

"If the AAAS is to be a vigorous force for the betterment of science, it cannot continue in the face of crucial situations with closed eyes and a dumb mouth." This responsibility has already been recognized. What is needed now is a way to meet it.

The recommendations which follow this report are intended to suggest some practical means of meeting this need. Primary among them is the recommendation that the AAAS take urgent steps to develop means for bringing before the appropriate policy-making groups, and the public generally, the pertinent facts and opinions regarding the great social issues which have emerged from recent scientific advances.

Cooper Union and Training the "Uncommon" Man

American education, in elementary and secondary schools as well as in professional schools, must be geared to the production of "uncommon" men and women, Edwin S. Burdell, president of The Cooper Union for the Advancement of Science and Art, said in his annual report to The Cooper Union trustees.

Unusually talented students must be discovered, must be specifically motivated toward the study areas in which their talents lie, and must receive training for leadership as well as for professional skill, according to the head of the tuition-free college that Peter Cooper Hon. Mem. ASME, founded in 1859. "In our commonwealth of tomorrow," he said, "these young people should become the uncommon men and women on whom society as a whole will depend."

"In tomorrow's technological world the best utilization of the best available brain power will be essential," Dr. Burdell said. "To achieve this, America has something to learn."

"Our American democracy has fought shy of elite groups, whether by birth, wealth, or brains. We have promoted an egalitarianism which runs the risk of defeating our efforts to meet our more pressing needs. The recent fad of applying the term 'egg head' to anyone who displays unusual intellectual ability seems to imply distrust of the intellectual as a sort of misfit in a mass of conformity. Be this as it may, the development of the potential brain power of intellectually superior men and women is our greatest need."

Dr. Burdell said that mass education had not solved the problem of educating the talented student and that many of the most talented youth are not even headed for college.

"A recent report of the Conservation of Human Resources Project at Columbia University maintains that among those individuals with the greatest aptitude for learning (those who score in intelligence tests in the upper 6 per cent of the population) less than half are graduated from college. The report goes on to point out that any personnel policy that differentiates sharply between college-trained and noncollege-trained is dangerous. The college-trained group includes many individuals of quite average and perhaps inferior ability, while the noncollege-trained group includes many very able persons.

"The crux of the problem is how to discover those most talented youths and to motivate them to seek the education and training needed to cope with the increasingly complex situation. If society is to survive, it must be as much concerned with the man of brains and integrity as it is with the enlightenment of the masses of mankind."

In summing up The Cooper Union's progress and anticipating the school's centennial two years from now, Dr. Burdell said the institution has a direct responsibility in the education of uncommon students because its free-tuition policy, amounting to a full scholarship for every student, enables the school to select its students from among the most talented who apply. He added that the school's Centennial Development Program, organized this year, was intended "to assure The Cooper Union's ability to meet the educational needs of an ever-expanding America and those of her greatest resource, the uncommon man."

This glass, steel, and concrete engineering school building will be the major feature of Cooper Union's $7 million development and modernization program. The building will house 25 laboratories, shops, and drawing rooms for chemical, civil, electrical, and mechanical engineering. Provision will be made for work in atomic and nuclear science.

Meetings of Other Societies

Feb. 19–21
Institution of Mechanical Engineers, Mechanical Engineers Contribution to Clean Air Conference, London, England

Feb. 25–27
American Management Association, third annual electronics conference, Hotel Statler, New York, N. Y.

Feb. 25–March 1
American Society of Heating and Air-Conditioning Engineers, annual meeting and exposition, Chicago, Ill.

Feb. 26–28
IRE, AIEE, and ACM, Western joint computer conference, Hotel Statler, Los Angeles, Calif.

March 7
Cleveland Engineering Society, 14th annual machine design conference, Cleveland, Ohio

(For ASME Coming Events see page 208)

People

Honors and Awards. EDWARD P. WARNER, Mem. ASME, retiring council president of the International Civil Aviation Organization, attended the January meeting of the ICAO in Paris. He has recently received the Wright Brothers Memorial Trophy, the Belgian title of Commander of the Crown, and the Flight Safety Award.

LILLIAN M. GILBRETH, Hon. Mem. ASME, one of the pioneers in industrial engineering and psychology, was honored at a testimonial dinner by Southern California engineers and their wives, January 31, in Los Angeles. Sponsoring organizations were the ASME Southern California Section, Systems and Procedures Association, Society for Advancement of Management, American Institute of Industrial Engineers, American Society for Quality Control, and Methods Time Measurement.

The Priestley Medal for 1957 of the American Chemical Society will be awarded to FARRINGTON DANIELS, professor of chemistry and chairman of the department, University of Wisconsin, and authority on atomic and solar energy, during the society's annual meeting in Miami, Fla., in April.

Six national honor awards for outstanding achievement in tool and manufacturing engineering will be presented this year by the American Society of Tool Engineers during the society's Silver Anniversary Meeting, March 25–27, in Houston, Texas. Four of the awards were inaugurated by the society in 1955, while two others, the ASTE Education Award and the ASTE Research Medal, are being offered for the first time this year. The 1956 winners and their respective awards are: JAMES H. KINDELBERGER, chairman of the board and chief executive officer, North American Aviation, Inc., the ASTE Progress Award; ORLAN W. BOSTON, Fellow ASME, ASTE Gold Medal; EDWARD W. ERNST, ASTE past-director, JOSEPH A. SIEGEL Memorial Award; and RALPH E. CROSS, executive vice-president, The Cross Company, ASTE Engineering Citation.

HOWARD S. BEAN, Fellow ASME, chief of the Capacity, Density, and Fluid Meters Section of the National Bureau of Standards, has received the Award of Merit of the Operating Section of the American Gas Association.

SIR ARNOLD HALL, technical director, scientific adviser, and consultant for the Hawker Siddeley Group, Ltd., London, England, delivered the Wright Brothers Lecture for 1956 of the Institute of the Aeronautical Sciences on December 17, at the U. S. Chamber of Commerce Building, Washington, D. C. Sir Arnold became director of the Royal Aircraft Establishment in 1951 at the age of 36 and was knighted three years later. He gained world recognition for his work in connection with the RAE inquiry into the causes of the Comet Airliner crashes. The task of nearly complete rebuilding of a wrecked Comet was undertaken and cause of the accidents found under his direction.

The American Institute of Electrical Engineers has announced that twelve members have been raised to the grade of Fellow—the Institute's highest grade. The members honored are: EDWARD R. COULBOURN, BURNS N. GAFFORD, JOHN R. MACINTYRE, CHARLES J. MILLER, JR., ALBERT H. MITTAG, KENNETH A. NORTON, THEODORE D. REIMERS, EDGAR W. ROBINSON, RONALD J. ROCKWELL, SEBASTIAN L. SCHEFFER, WILLIAM K. SONNEMAN, EARL W. TIPTON.

Three of the top honors in chemical engineering were presented to outstanding members of the profession, December 11, in the Hotel Statler, New York, N. Y., during the Awards Banquet of the American Institute of Chemical Engineers, and 1957 officers were introduced. In the award ceremony, Walter G. Whitman, president of the Institute, presented the William H. Walker Award to EDWARD W. COMINOS, head of the School of Chemical and Metallurgical Engineering, Purdue University; the Professional Progress Award in chemical engineering to ROBERT ROY WHITE, University of Michigan; and the Junior Award to THEODORE WEAVER of the Fluor Corporation, Ltd., Los Angeles. The 1957 officers introduced were: J. HENRY RUSHTON, Purdue University, president; GEORGE E. HOLBROOK, E. I. du Pont de Nemours & Company, Wilmington, Del., vice-president; GEORGE G. BROWN, University of Michigan, treasurer; and F. J. VAN ANTWERPEN, Nutley, N. J., secretary.

Appointments. GLENN B. WARREN, Fellow ASME, vice-president of the General Electric Company, was appointed consulting engineer for the Turbine Division of that company, January 1.

WILLIAM C. MENZIES, JR., has been appointed to the post of technical director of the Lowell Technological Institute Research Foundation. He will succeed GEORGE O. LANGLAIS who has accepted a position in technical services with Monsanto Chemical Company in Springfield, Mass.

New Officers. MUNDY I. PEALE, president of Republic Aviation Corporation, has been elected president of the Institute of the Aeronautical Sciences for 1957. He succeeds Edward R. Sharp, director of the NACA Flight Propulsion Laboratory, and will be the 25th president of the Institute.

Campus News. THORNDIKE SAVILLE, dean of the New York University College of Engineering for the past 20 years, will retire with the start of the 1957 fall term. Under his direction the NYU College of Engineering formed a Graduate Division and a Research Division. The Research Division, conducting projects under sponsorship of private industry, foundations, and government agencies, has an annual budget of $2,866,000.

EDMUND E. WEYNAND of Fort Worth, Texas, has been appointed associate professor of mechanical engineering at Southern Methodist University, Dallas, Texas.

D. B. STEINMAN, consulting engineer, New York, N. Y., has made a grant, through the David B. Steinman Foundation, of $10,000 to The Cooper Union for the Advancement of Science and Art. The fund will be used for scholarship-loan purposes for engineering students of the college, as well as for graduates who need financial assistance in pursuing graduate engineering studies.

Retirement. J. H. R. ARMS, Mem. ASME, retired on Dec. 31, 1956, as secretary-general manager of United Engineering Trustees, Inc. He will continue as secretary of the John Fritz Medal Board of Award and Daniel Guggenheim Medal Board of Award. A testimonial dinner was tendered in his honor in New York City, December 27.

Education

Atomic Studies at Columbia

COLUMBIA UNIVERSITY has announced formation of a "Council for Atomic Age Studies" representing the fields of physics, law, philosophy, engineering, journalism, medicine, business, and others. Objective is to make the University a center for the study of problems facing society as a result of the development of atomic energy.

Among the members of the new Council are: I. I. Rabi, Higgins professor of physics and Nobel Prize winner; Philip C. Jessup, Hamilton Fish professor of international law and diplomacy and former U. S. Ambassador-at-large; Edward W. Barrett, dean of the Graduate School of Journalism and former Assistant Secretary of State; John G. Palfrey, professor of law, formerly with the Office of General Counsel of the Atomic Energy Commission; and John M. Kernochan, professor of law and director of the University's Legislative Drafting Research Fund.

ASME News

With Notes on Society Activities and Events

E. S. Newman, *News Editor*

1957 Nuclear Congress Program Lists 39 ASME Papers

THE 1957 Nuclear Congress, described as "possibly the most significant event of its kind ever held in this country," will be held at the Philadelphia (Pa.) Convention Hall, March 11–15. The Congress is sponsored by more than 20 engineering and technical societies and will include a concentrated program of more than 200 technical papers, of which 39 are ASME papers. The Engineers Joint Council co-ordinated the program.

The two-day conference for business executives interested in atomic energy also features an International Atomic Exposition where new developments related to peacetime nuclear operations will be displayed.

More than 40 major topics will be considered at the Congress, including nuclear generating stations, reactors for ship propulsion, disposal of radioactive wastes, production of atomic fuels, legislative and legal problems, atomic energy developments abroad, and practical, commercial applications of the atom in such fields as chemical production and food processing.

The ASME papers to be presented at the Nuclear Engineering and Science Conference include the following:

MONDAY, MARCH 11

9:30 a.m.

Plant Containment Concepts and Design

Chairman: *Lewis R. Gaty*

Vice Chairman: *W. C. Siler*

Consolidated Edison Containment System, by *H. F. Dobel* and *D. W. Montgomery*, The Babcock & Wilcox Co.

Containment for the EBWR, by *L. W. Fromm* and *A. Heineman*, Argonne National Laboratory

Nuclear Systems Containment Vessels, by *A. J. Raymo*, General Electric Co.

TUESDAY, MARCH 12

9:30 a.m.

Primary Coolant Systems

Chairman: *Wayne H. Jens*

Vice Chairman: *J. P. Hartnett*

Engineering Consideration in the Use of an Organic Reactor Coolant, by *W. E. Parkins*, et al., Atomics International

Boiling Water as a Primary Coolant, by *Sam Untermeyer*, General Electric Co.

Gas Coolant for Nuclear Reactors, by *M. Silberberg*, Ford Instrument Co.

Operation Sodium Coolant SRE, by *J. E. Nolan*, Westinghouse Electric Corp.

Operational Experience With a UO-NaK Slurry in a Loop at 600 C, by *H. E. Flotow, R. D. Carlson*, and *B. M. Abraham*, Argonne National Laboratory

2:30 p.m.

Plant Components—Small

Chairman: *J. Frank Roberts*

Vice Chairman: *Leonard Koch*

Electromagnetic and Mechanical Pumps of EBR Sodium System, by *R. A. Jaross* and *O. H. Seim*, Argonne National Laboratory

Use of Clad Piping, by *J. H. Proctor*, Lukens Steel

Piping as Applied to Nuclear Energy Applications, by *D. B. Rossheim, J. J. Murphy, C. K. Soderberg*, and *H. S. Blumberg*, M. W. Kellogg Co.

On Quality Requirements for Steel Valves for Nuclear Power Plants, by *J. J. Kanter*, Crane Co.

60-Cycle Induction Heating of Sodium Systems, *R. A. Jaross* and *O. H. Seim*, Argonne National Laboratory

New Limits and Codes for Radiation Protection

Chairman: *J. W. Healy*

Vice Chairman: *C. M. Paterson*

Changes in Maximum Permissible Exposure Values Recommended in 1956 by the International Commission on Radiological Protection, by *K. Z. Morgan*, Oak Ridge National Laboratory

The Impact of the Lowered Radiation Exposure Limits on Radiation Control Problems, by *L. S. Taylor*, National Bureau of Standards

Status of Radiation-Protection Legislation and Codification, by *W. A. McAdams*, General Electric Co.

Regulations Controlling the Use of Radioactivity by AEC Licensees, by *Forrest Western*, Atomic Energy Commission

Statistics on Radiation Exposures for Use in Labor, Insurance, Economic and Scientific Studies, by *W. D. Claus*, Atomic Energy Commission

WEDNESDAY, MARCH 13

9:30 a.m.

Plant Components—Large

Chairman: *Arthur N. Anderson*

Vice Chairman: *M. C. Beekman*

Boilers for Nuclear Power Plants, by *John Carlinhour*, Foster Wheeler Corp.

Pressure Vessels for Nuclear Power Plants, by *S. L. Lindbeck* and *Arnold Halporn, Jr.*, Westinghouse Electric Corp.

Basic Equations for Predicting Performance of a Nuclear Power Plant Pressurizer, *T. Glasser*, Knolls Atomic Power Laboratory

Fuel-Handling System for a Fast Breeder Reactor, by *J. E. Seward* and *C. P. Nash*, Atomic Power Development Associates

9:30 a.m.

Radiation Processing

Chairman: *Philip N. Powers*

Vice Chairman: *A. V. Peterson*

Use of Ionizing Radiations in Control of Parasitic Infections, by *J. Villella, H. J. Gomberg*, and *S. E. Gould*, University of Michigan

Basic Concepts in the Application of Ionizing Radiations to Foods for Preservation, by *D. H. Rest, B. H. Morgan, G. E. Danald, G. E. Tripp*, and *M. Simon*, Quartermaster Corps, U.S. Army

A Megacurie Cobalt-60 Food Irradiator, by *B. Manowitz, O. A. Kuhl*, and *Leonard Galanter*, Brookhaven National Laboratory

Peacetime Utilization of Ionizing Radiation to the Chemical Industry, by *K. H. Sun*, Radiation & Nucleonics Laboratory, Westinghouse Electric Corp.

The Nuclear Reactor as an Instrument of Medical Research and Therapy, by *E. Stickley, G. S. Robertson*, and *L. E. Farr*, Brookhaven National Laboratory

9:30 a.m.

Reactor Design

Chairman: *L. Macklin*

Vice Chairman: *D. J. Woodruff*

Engineering Aspects of the Nuclear Design of Power Reaction, by *M. J. Galper* and *O. J. Woodruff, Jr.*, Westinghouse Electric Corp.

Nuclear Powered Gas Turbines for Lightweight Power Plants, by *F. Hammitt* and *H. A. Ohlgren*, University of Michigan

Considerations in the Design of Pressurized Water Reactor Plants, by *J. E. Nolan* and *J. R. LaPointe*, Westinghouse Electric Corporation

Design and Construction of the Engineering Test Reactor, *P. D. Bush*, Kaiser Engineers

Stress Corrosion Cracking Problems in the Homogeneous Reactor Test (HRT), by *E. G. Bohlman*, Oak Ridge National Laboratory, and *G. M. Adamson*, Oak Ridge National Laboratory

WEDNESDAY, MARCH 13

2:30 p.m.

Reactor Core Design

Chairman: *Kenneth W. Davis*

Vice Chairman: *W. J. McCarthy, Jr.*

EBR-II Control Drive Mechanism, by *Ernest Hutter*, Argonne National Laboratory

On the Significance of Reynolds Number on Reactor Design, by *F. L. Jackson, J. P. Waggener*, Nuclear Power Section, and *J. S. Busch, Luther S. Harman*, Westinghouse Atomic Power Division

THURSDAY, MARCH 14

9:30 a.m.

Reactor Control and Simulators

Chairman: *Rufus Oldenberger*

Vice Chairman: *M. A. Schultz*

Control Problems in Nuclear Power Plants, by *J. E. Owens*, Atomics International Division of North America

The Development of a Universal-Type Control Drive Mechanism for Nuclear Reactors, by *Charles Hinrichs* and *Gilbert Rolan*, American Machine & Foundry Co.

2:30 p.m.

Problems Related to Heat Transfer

Chairman: *S. W. Churchill*

Vice Chairman: *R. V. Bailey*

Transient Thermodynamics of Reactor and Process Apparatus, by *D. H. Brown*, Knolls Atomic Power Laboratory

Electrical Problems in Electrical Burnout Testing of Nuclear Fuel Elements, by *T. W. Hunt*, Westinghouse Electric Corp.

Mechanical and Thermal Problems of Water-Cooled Nuclear Power Reactors, by *N. J. Palladino* and *J. Sherman*, Westinghouse Electric Corp.

Time and Temperature Dependence of Thermal Stresses in Cylindrical Reactor Fuel Elements, *K. R. Merckla*, General Electric Co.

ASME Coming Events

March 10–15
Nuclear Congress, Convention Hall, Philadelphia, Pa.

March 18–21
ASME Gas Turbine Power Conference, Hotel Sheraton-Cadillac, Detroit, Mich.

March 27–28
ASME Engineering Management Conference, Hotel William Penn, Pittsburgh, Pa.

April 7–10
ASME Spring Meeting, Hotel Dinkler-Tutwiler, Birmingham, Ala.

April 8–10
ASME Instruments and Regulators Conference, Northwestern University, Chicago, Ill.

April 25–26
ASME Railroad Conference, Hotel Sheraton, Chicago, Ill.

April 25–26
ASME-SAM Management Conference, Hotel Statler, New York, N. Y.

May 16–17
ASME Wood Industries Conference, Winston-Salem, N. C.

May 19–23
ASME Oil & Gas Power Conference, Kentucky Hotel, Louisville, Ky.

May 20–23
ASME Design Engineering Conference, Coliseum, New York, N. Y.

June 9–13
ASME Semi-Annual Meeting, Sheraton-Palace Hotel, San Francisco, Calif.

June 13–15
ASME Applied Mechanics Conference, University of California, Berkeley, Calif.

August 11–15
ASME Heat Transfer Conference, Pennsylvania State University, University Park, Pa.

Sept. 9–13
ASME IRD-ISA Conference, Auditorium, Cleveland, Ohio

Sept. 22–25
ASME Petroleum Mechanical-Engineering Conference, Hotel Mayo, Tulsa, Okla.

Sept. 23–25
ASME Fall Meeting, Hotel Statler, Hartford, Conn.

Oct. 7–9
ASLE-ASME Lubrication Conference, concurrently with ASME-IMechE International Conference on Lubrication and Wear, Royal York Hotel, Toronto, Ont., Canada

Oct. 8–12
ASME-AIME Fuels Conference, Chauteau Frontenac, Quebec, Que., Can.

Dec. 1–6
ASME Annual Meeting, Hotel Statler, New York, N. Y.

(For Meetings of Other Societies, see page 206)

Schedule 1957 RAC Meetings

Date	*Day*	*Place*	*Hotel*	*Region*
March 29–30	Fri.–Sat.	Peoria, Ill.	Pere Marquette	VI
April 4–5	Thurs.–Fri.	Mexico City	Continental Hilton	VIII
April 6–7	Sat.–Sun.	Birmingham, Ala. (Spring Meeting)	Dinkler-Tutwiler	IV
April 11–12	Thurs.–Fri.	Rochester, N. Y.	Sheraton	III
April 19–20	Fri.–Sat.	Richland, Wash.	Desert Inn	VII
April 29–30	Mon.–Tues.	Toledo, Ohio	Park Lane	V
May 1–2	Wed.–Thurs.	New York, N. Y.	Headquarters	II
May 3–4	Fri.–Sat.	Bridgeport, Conn.	Barnum	I

Palm Sunday, April 14
Good Friday, April 19
Easter Sunday, April 21

Literature

IBM Research

"The IBM Journal of Research and Development," to be published quarterly, began Jan. 1, 1957, with comprehensive articles on IBM research here and abroad in fields as varied as solid-state physics, chemistry, metallurgy, information theory, and electronics. Other articles will treat the latest developments in computers, data-processing machines, and design of components such as magnetic-core memories and semiconductor devices. The magazine will be available by subscription from International Business Machines Corporation, 590 Madison Avenue, New York 22, N. Y., at $3.50 a year.

Creative Engineering

"Creative Engineering," a recent compilation of nine papers emphasizing the importance of ingenuity, intuition, and creative ability in the engineering profession and suggesting how these qualities may be encouraged and developed, has been issued by The American Society of Mechanical Engineers. Several essays are retained from the 1944 publication of the same title which has long been of influence in the profession. Copies are available for $1 a copy from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.

The General Arrangements Committee for the 1957 ASME Spring Meeting is shown at a planning session. The meeting will be held at the Dinkler-Tutwiler Hotel, Birmingham, Ala., April 7–10. Seated, *left to right*: Glenn Almond, Kenneth Daniel, Lawrence Brownlee, Herbert Kuenzel, Francis O'Brien, chairman, Birmingham Section; George Bentley, and D. B. MacDougall, ASME Meetings Manager. Standing, *left to right:* John Mummert, Joseph Eshelman, John Little, Pat Payne, Wiley Karrh, chairman, North Alabama Subsection, and James Sloan.

Detroit's skyline, where the ASME Gas Turbine Power Conference will be held March 19–21 at the Sheraton-Cadillac Hotel, looking south toward the Detroit River and Windsor, Ont., Canada

Gas Turbine Power Conference to Be Held in Detroit

BEGINNING Monday, March 18, the Gas Turbine Power Division of The American Society of Mechanical Engineers will hold its second annual conference and exhibit covering gas turbines for industrial and marine application of the gas turbine. It will be held in the Sheraton-Cadillac Hotel in Detroit, Mich., and the technical papers will be delivered from March 19 to 21. The exhibit will open on March 18 and will remain on view through the 21st.

The exhibit is said to be larger and more interesting than last year and consists of a large repeat business from last year's exhibit plus several new exhibitors.

We are told by those in charge of the Conference that it and the exhibit should be included in every engineer's coverage of gas-turbine activity.

The tentative technical program follows:

TUESDAY, MARCH 19

Session 1

9:30 a.m.

Chairman: *T. J. Putz*, manager, Gas Turbine Engineering, Westinghouse Electric Corporation, Lester, Pa.

Vice Chairman: *D. N. Frey*, associate director, Scientific Laboratory, Ford Motor Company.

Gas Turbines in the Chemical Industry, by *Z. S. Stys*, Brown Boveri Corp., New York, N. Y.

Influence of Working Fluid Characteristic on the Design of the Closed Cycle Gas Turbine,[1] by *S. T. Robinson*, American Turbine Corp.

Design Requirements for Marine Gas Turbines[1]

Session 2

2:00 p.m.

Chairman: *O. E. Rodgers*, chief engineer, Utica Bend Corporation, Utica, Mich.

Vice Chairman: *G. J. Huebner*, executive engineer—Research, Chrysler Corp.

Design of a 16,500-Kw Gas Turbine,[1] by *A. O. White*, General Electric Co., Schenectady, N. Y.

A New Single Shaft 3000-Hp Gas-Turbine Ideal for Mechanical Drive Application,[1] by *J. Viatta*, Westinghouse Electric Corp.

Session 3

8:00 p.m.

Chairman: *B. G. A. Skrotzki*, engineering and management editor, *Power*, McGraw-Hill Publishing Co., New York, N. Y.

Vice Chairman: *B. H. Howell*, professor, mechanical engineering, Wayne State University, Detroit, Mich.

Development of Gas Turbines for Road Vehicles,[1] by *A. Carelli*, Gas Turbine Engineer, Fiat, Italy.

The Austin Vehicle Gas Turbine,[1] by *J. H. Weaving*, Austin Motor Company, England.

[1] Paper not available. See box on this page.

WEDNESDAY, MARCH 20

Session 4

9:30 a.m.

Chairman: *P. R. Stoller*, president, Brown Boveri Corp., New York, N. Y.

Vice Chairman: *L. L. Otto*, professor, mechanical engineering, Michigan State University, East Lansing, Mich.

Determination of Turbine Stage Performance for an Automotive Power Plant[1]

Analytical Methods for Performance Estimates of Free Piston Gasifiers[1]

THURSDAY, MARCH 21

Session 5

9:30 a.m.

Chairman: *B. O. Buckland*, consultant, Gas Turbine Department, General Electric Co., Schenectady, N. Y.

Vice Chairman: *J. J. Ucker*, chairman, mechanical engineering department, University of Detroit.

Designing Thermocouples for Response Rate,[1] by *R. J. Moffat*, General Motors Corp.

A Generalized Presentation of Gas-Turbine Combustor Performance,[1] by *A. E. Noreen* and *W. T. Martin*, General Electric Co., Cincinnati, Ohio.

Session 6

2:00 p.m.

Chairman: *E. P. Vincent*, professor of mechanical engineering, University of Michigan, Ann Arbor, Mich.

Vice Chairman: *W. A. Turunen*, head, Gas Turbine Department, Research Staff, General Motors Corp., Detroit, Mich.

Gas-Turbine Generating Experience of West Texas Utilities Company,[1] by *A. R. Cox*, West Texas Utilities Co.

Gas-Turbine Maintenance in Severe Service,[1] by *R. C. Hill*, Union Pacific Railroad Co.

Orders for Technical Papers

ONLY copies of numbered ASME papers will be available. Some of these papers may not be available in time to permit your receiving them in advance of the Conference. Your order will be mailed only when the complete order can be filled unless you request that all papers available ten days before the meeting be mailed at that time. Please order only by paper number, otherwise the order will be returned. The final listing of available technical papers will be found in the issue of MECHANICAL ENGINEERING containing an account of the Conference.

Copies of ASME papers may be obtained by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 25 cents each to members, 50 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons, or coupons which may be purchased from the Society. The coupons in lots of ten are $2 for members, and $4 for nonmembers.

Copies of unnumbered papers, listed in the program, are not available because the review of these manuscripts had not been completed when the program went to press. The author's name and paper number will appear with paper title in the program, as well as the issue of MECHANICAL ENGINEERING containing an account of the Conference.

Engineering Management Controls Themes Conference to Be Held March 27–28

Penn-Sheraton Hotel, Pittsburgh, Pa., headquarters for management meeting

THE American Society of Mechanical Engineering Engineering-Management Conference to be held at the Penn-Sheraton Hotel, Pittsburgh, Pa., on March 27–28, will have as its theme "Engineering-Management Controls."

The two-day meeting, sponsored by both ASME and the American Institute of Electrical Engineers, is designed to place emphasis on control through organization, control through management development, control through electronic data processing, and control of engineering effort in research and development.

Leaders in each of these fields will present operating suggestions and techniques that have resulted in better control and less cost. Operating management in the fields of engineering management, plant management, production control, research, and personnel will find suggestions and ideas meriting their attendance.

The tentative program is as follows:

MARCH 27

Control Through Organization.

10:00 a.m.

Control of the Engineering Function in a Decentralized Company, by *G. F. Habach*, Worthington Corp., Harrison, N. J.

Planning and Scheduling the Engineering Work Load for Maximum Utilization of Engineering Staff, by *F. H. Meyer*, Methods Engineering Council, Pittsburgh, Pa.

Luncheon

Address by: *J. A. Hutcheson*, vice-president of engineering and research, Westinghouse Electric Corp., Pittsburgh, Pa.

P.M. Session

Control Through Management Development

Developing Engineers for Management, by *H. B. Kiphuth*, Westinghouse Electric Corp., Bettis Atomic Power Division, Pittsburgh, Pa.

Tailoring a Training Program to Company Needs, by *C. A. Jurgensen*, De Laval Steam Turbine Co., Trenton, N. J.

Development of Engineering Managers Through Planned Education and Training, by *Melvin Anshen*, Carnegie Institute of Technology, Pittsburgh, Pa.

Dinner

Address by: *William F. Ryan*, ASME President.

MARCH 28

Control Through Electronic Data Processing

9:00 a.m.

What the Engineer Can Do With Data Processing Equipment, by *C. R. DeCarlo*, International Business Machines Co., New York, N. Y.

Production and Inventory Control With Electronic Equipment, by *E. S. MacMichael*, American Bridge Division, United States Steel Corp., Pittsburgh, Pa.

Control of Design and Engineering Procedure Through Electronic Data Processing Equipment

Group presentation by General Electric Co., Schenectady, N. Y

D. H. Ware, Manager of Engineering, Medium A.C. Motor and Generator Dept.

W. J. Martiny, Project Engineer Computors, Medium A.C. Motor and Generator Dept.

Frank Maginniss, Manager, Special Engineering Investigation, Apparatus Sales Division

Luncheon

Speaker: *H. Thomas Hallowell, Jr.*, president, Standard Pressed Steel Co., Jenkintown, Pa. and president, American Standards Association

Subject: **Standardization—An Aid to Management Control.**

P.M. Session

Control of Engineering Effort in Research and Development

Where and How Should Your Research Dollars Be Spent, by *P. W. Bachman*, Koppers Co., Pittsburgh, Pa.

Control of Research and Development Effort to Meet Company Objectives, by *Aaron Wexler*, Westinghouse Research Laboratory, Pittsburgh, Pa.

ASME Management Division Conference General Arrangements Committee shown at the Engineers' Society of Western Pennsylvania, Pittsburgh, Pa., following completion of preliminary plans for 1957 Management Conference, March 27–28, at Penn-Sheraton Hotel. The Committee seated, *left to right,* are: V. B. Baker, AIEE, chairman, Reception Committee; H. R. Fulton, ASME, chairman of Pittsburgh Section; H. B. Kiphuth, AIEE, vice-chairman, Conference Committee; D. E. Farr, ASME, chairman, General Arrangements Committee; D. W. Ver Planch, vice-chairman, General Arrangements Committee; and Charles Punton, ASME, chairman, Registration Committee. Standing, *left to right,* are: J. R. Aikins, ASME, chairman, Publicity Committee; Lee Tarn, AIEE, vice-chairman, Publicity Committee; A. L. Bayles, ASME, vice-chairman, Reception Committee; H. L. Shakeshaft, ASME, vice-chairman, Hotel and Entertainment Committee; P. A. Beckjord, AIEE, chairman, Hotel and Entertainment Committee; and E. W. Brewer, AIEE, vice-chairman, Registration Committee. W. R. Harris, AIEE, vice-chairman, Finance Committee; and K. F. Treschow, chairman, Finance Committee, were unable to attend the meeting.

Thought-Provoking—Gordon Research Conferences

GORDON RESEARCH CONFERENCES, an unusual affiliate of the American Association for the Advancement of Science whose meetings are never reported, statements quoted, or papers published, have proved the value of professional bull sessions and celebrated their Silver Jubilee in December.

Through free and unhurried discussion among top-flight research men, particularly those working in highly specialized areas, they offer a unique chance for cross-fertilization of scientific ideas, and have accumulated a long and distinguished roster of participants.

Any scientist can apply for attendance at one of the 36 conferences held each summer on the campuses of three New Hampshire schools: Colby Junior College, New Hampton School, and Kimball Union Academy. But only the most promising receive an invitation to join the informal groups for recreation and idea-swapping.

At a 1936 Conference, Enrico Fermi first described his transmutation of the

heavier elements by bombardment with slow neutrons; a later session heard of the first synthesis of quinine and vitamin B_{12}. Improvements in carbon black discussed at one meeting made possible the long-wearing, reliable tires on today's cars. Professor Guido Natta, who has developed a potentially important process for making special high-molecular-weight plastics, came from the Milan Polytechnic Institute to attend GRC sessions this summer.

The conferences are named for Dr. Neil E. Gordon, chemistry professor at The Johns Hopkins University, who decided in 1931 to act on his long-standing belief that growing scientific specialization made it difficult for scientists to work effectively on broader-range human problems.

1957 Society Records Sent Upon Request

MEMBERS of The American Society of Mechanical Engineers who wish to receive copies of February, 1957, issues of Society Records containing the personnel of the Council, Boards, and Committees (AC-10) and the Constitution and By-Laws of the Society (MM-1) may do so by requesting the pamphlets from the Secretary, ASME, 29 West 39th Street, New York 18, N. Y.

ASME Railroad Division Plans Meeting in Chicago, April 25-26

THE Railroad Division of The American Society of Mechanical Engineers will hold a Technical Conference in Chicago, Ill., at the Sheraton Hotel on April 25-26, 1957. The Sheraton Hotel is on Chicago's lake front.

The technical program will cover a wide range of current problems now confronting the railroad industry. The morning and afternoon sessions on April 25 will be devoted to locomotive affairs while the morning and afternoon sessions on April 26 will cover car-department problems.

A symposium on the use of economy-type diesel fuel in locomotives will occupy the morning session on April 25, with the afternoon session centered around proper test techniques and equipment used in diesel engine and locomotive maintenance.

The morning session on April 26 will be concerned with a broad review of performance standards and recent developments in roller-bearing freight trucks, draft gears, and "piggy-back" equipment. The afternoon session on April 26 will be a symposium on corrosion prevention in freight cars including a thorough treatment of aluminum as a material for construction.

A Railroad Division luncheon is planned for April 26 for ASME members and guests.

A formal banquet and cocktail party for members, conference guests, and their ladies is scheduled for the evening of April 25. The principal address at the banquet will be given by W. F. Ryan, President of ASME.

An additional social function for the women is scheduled for April 25 at noon, and will consist of luncheon at the famous Kungsholm restaurant with a performance of the miniature opera following lunch.

The Conference will adjourn at 5:00 p.m., on April 26.

Registration and attendance of railroad personnel is urged most seriously. This conference is intended to be the first of a series of forums where reflective and advanced thinking on railroad problems can be considered.

A considerable emphasis is being placed on securing co-operation of technical schools and universities in the Chicago area to urge railroad-minded students in for the meetings. Every effort will be made to underwrite the cost of publishing the technical papers so that an entire docket of papers might be presented to each registering student.

Junior Forum

Conducted for the National Junior Committee

by R. A. Cederberg,[1] Assoc. Mem. ASME

Planning a Student Section Meeting on Industrial Indoctrination

By J. H. Weinstein[2]

THE purpose of this article is to present information and procedures on how to organize and present a program showing engineering students the application of engineering methods and principles to the everyday practice of engineering.

The planning and execution of such a meeting will bring together members of the Student Section, the Parent Section, the Old Guard, the National Junior Committee, and those young engineers participating in the program.

Through this interaction of the various levels of membership within the Society a more integrated Student Section program will result. But even more important, the students, besides getting a glimpse of what will be expected of them upon graduation, will also become more conscious of a purposeful association with a professional society and have an early understanding of and acquaintance with different segments of the ASME organization. Thus, after graduation, the transition to active participation in Society affairs will not be so difficult.

In the spring of 1956, the Student Section Subcommittee of the National Junior Committee, with the support of the Old Guard, the Northern New Jersey Subsection, and the Vice-President of Region II, helped the Student Branches of the Newark College of Engineering and the Stevens Institute of Technology to plan and carry out a meeting to acquaint the students with the way engineering is employed on the job and also to stimulate their interest in ASME.

[1] Remington Rand Univac, St. Paul, Minn.
[2] Assoc. Mem. ASME, Brooklyn, N. Y.

J. H. Weinberg, *left*, is shown chatting with J. J. Horan of the Atomic Energy Division of the Babcock & Wilcox Co., and Joel Schnur, Student Program Chairman at Newark College of Engineering. The photo was taken following a student section meeting on atomic reactors.

First Meeting

The main portion of the program was a description of a panel of four young mechanical engineers of their daily and weekly tasks at work. These men were chosen from different branches of industry. Each represented an area where mechanical engineering is applied. The panel members were young engineers, each one having graduated within the past ten years. In order to guide the panel members on what should be included in their presentation and to suggest to them a manner in which this information might be gathered, a preparatory letter of instruction was sent to them.

After the meeting a questionnaire was sent to each student who had filled out an attendance card in order to evaluate how well the program was received, what faults the students found, and what corrections or improvements they might suggest.

Members of the Society, other than students, who attended the meeting were also canvassed for comment and suggestions.

The Questionnaire

The purpose of this questionnaire is to get an accurate rating of the usefulness of the ASME meeting which you attended on March 29. You will note that no name is required which should make you feel free to give your honest evaluation of the session.

Please check each of the twelve questions and if possible add any other criticism or suggestions on the back of the sheet. Your help will be sincerely appreciated.

Analysis of Questionnaire

1 Of the 60 questionnaires sent out 35 replies were received. The preponderance of Seniors indicates that this subject is of great interest to those about to graduate, which was to be expected.

2 The positive replies to questions 1, 2, 6, and 9 indicate that the basic idea and purpose of the meeting were accomplished and found favor with the audience. The unanimous affirmative reply to question 6 is of special significance and an annual meeting of this type would seem to be appropriate.

3 The response to questions 4 and 5 would seem to indicate a preference for a panel composed of three to four young engineers plus one or two men who are in a supervisory capacity.

4 The large number of negative replies to question 10 would seem to indicate that the presentation of information on ASME was far from adequate. The combination of questions 10, 11, and 12 shows that the group which attended the meeting is interested in participation in the Society, but that our communications with them have not been sufficient to present a clear picture of the organization and its functions.

Preparation and Organization of Meeting

1 The meeting should be held in January or February before the normal campus recruiting program gets into high gear.

2 The panel should consist of four young engineers from four different branches of industry plus one engineering supervisor.

3 The student who is to act as chairman of the meeting, with the help of the Faculty Adviser, should communicate with an officer of the local Section who can aid him in locating speakers. The National Junior Committee offers its resources of personnel and associations in locating suitable panel members.

4 Once the speakers have accepted and the location, time, and date are set, a good publicity campaign should be instituted. Members of the local Section should be invited as well as all engineering students in the area.

Sample of Meeting Questionnaire

Soph. 1 Jr. 3 Sr. 31

1	Did you find the meeting enjoyable?	Yes	35	No	0
2	Did you find the meeting useful?	Yes	30	No	4
3	Do you feel that most of the speakers did a good job?	Yes	33	No	1
4	Do you prefer to hear from executives rather than young engineers?	Yes	6	No	23
5	Would you prefer some young men and some executives on the panel?	Yes	28	No	4
6	Do you think this type of meeting should be an annual event?	Yes	35	No	0
7	If so should it be held earlier in the year?	Yes	25	No	8
8	Would it be profitable to have two such meetings?	Yes	20	No	13
9	Would you like to attend another meeting with a similar program but covering other fields?	Yes	29	No	6
10	Did the information presented help you to get a better picture of ASME?	Yes	25	No	10
11	Do you plan to be active in ASME?	Yes	33	No	1
12	Do you want more information about ASME?	Yes	31	No	3

5 A member of the National Junior Committee, or someone thoroughly familiar with the problems of the young men in ASME and the steps being taken to help them should be invited to speak during the second part of the meeting. If no such person is available locally, get in touch with the National Junior Committee through Society headquarters.

6 A letter similar to the one given elsewhere in this article should be sent to each panel member, explaining the type of talk expected of him, and suggesting how he can gather the material to be presented.

7 The Student Chairman should be thoroughly familiar with the check list he must follow to conduct a good meeting.

Letter to Panel Members

You have been asked to participate in a panel discussion to be held at a meeting of an ASME Student Branch at a nearby college. The purpose of this letter is to help you prepare for that panel so that the students may derive the maximum benefits from your experience in the field.

Most Student Sections hear quite a few speakers from industry during a school year. Often when a speaker attempts to describe his field of work to the students, he describes it in terms which are meaningful to anyone who has worked on the job, but which lack detail and fail to pinpoint meaning as far as the student is concerned. Such terms as design, develop, calculate, analyze, schedule, and direct are less meaningful to the student who has never worked in the particular field being described, and who is looking for some concrete idea of what his day-to-day tasks will be if he enters this field. It is the purpose of this panel, of which you will be a member, to present to the students a clear picture of the day-to-day duties of an engineer in industry.

This task is not always as simple as it sounds. Try asking a friend to describe in detail what he does on the job. Chances are it will take quite a bit of questioning before you have a good picture of his work. This is not unusual. Few of us are ever called on for such a description.

The following technique has been found useful in organizing material for this type of help.

A diary type of notebook is kept in a handy position on the office desk. Notes on the task being performed are made from time to time during the day as thought necessary. At least two entries per day should be made.

After several weeks of gathering material in this manner, an outline is prepared of job performance for the period under consideration. This becomes the first part of the talk. The second part is of a more general nature. It describes other phases of the job which either do not appear during the logged period, or which need further elaboration. These points can often be made more effective by relating them to material which came out of the log.

The entire talk should take approximately ten minutes. This is admittedly a short time in which to give a good picture of your job but there are four other such descriptions, followed by a question period. Items which have been omitted during the talk may be used during the question period.

May I take this opportunity to thank you for your willingness to participate as a member of the panel. Those of us associated with the project feel that it will be of great value to the students and I am sure that you will find your participation a most satisfying experience.

A reminder giving the exact time and place will be sent to you one week before the meeting.

ASME Codes and Standards Workshop

Handbook for Small Sawmill Operators Published

By F. C. Simmons and James R. Bethel

A VERY substantial proportion of the lumber produced by the American lumber industry is manufactured on small sawmills. Lumber that is poorly manufactured from the standpoint of uniformity of dimension may be the cause of complaint by the lumber buyer, and is costly to the manufacturer because of excessive waste. This problem has been the subject of much research and there is ample evidence to show that small sawmills can produce accurately sized lumber. If the small mills are well constructed, properly maintained, and correctly operated, they will produce lumber that is satisfactory for every type of use. The purpose of this Handbook is to summarize the causes of miscut lumber in small mills, and to indicate the action that the small sawmill operator can take to eliminate these causes when they appear in his operation.

The term "small sawmill" has never been exactly defined. It has a different meaning for people from different parts of the country. Sawmills may be classified as small or large on the basis of cost, production rate, size of saw, or size of power unit. None of these bases for classification is completely satisfactory. Productive capacity per day is most often used. In the Pacific Northwest, a sawmill cutting 20,000 board feet a day would be considered a small sawmill. In southern New England a mill cutting at this rate would be considered a large sawmill.

Moreover, mills with essentially the same equipment and the same amount of manpower cut at widely different rates, depending on the thicknesses produced, the size of the logs handled, whether they are cutting hardwoods or softwoods, and how much attention is paid to grade or quality of product.

For the purpose of this Handbook a small sawmill was considered to be one that is cutting less than 20,000 board feet per day of boards, dimension, or timbers, for the commercial lumber market. No effort will be made to consider the special problems of the very small mill cutting material for home use, or the local custom market.

Need for Dimensional Control

Lumber which is too thin has limited usefulness. If it is delivered to the customer, it is likely to be unsuitable for the purpose intended. This, of course, creates customer ill-will, makes repeat sales more difficult, and creates an atmosphere in which the sales of lumber substitutes are likely to flourish. If the thin lumber is not delivered to a customer, it must be remanufactured to a smaller standard dimension, sold as cull, or carried out with the slabs and edgings. None of these courses represents good business practice.

Many lumber manufacturers, recognizing the desirability of eliminating thins, go to the other extreme and set for such a heavy over-thickness that even

the thinnest boards meet the minimum-size specifications.

It has been found that many small sawmills put from 10 to 20 per cent more volume into their product than is needed. This also means higher costs and prices, lower profits, and poor market position as to competitive materials.

The answer to the sawmill operator's problem is to do an accurate sizing job. It is recognized, of course, that it is impossible to produce all lumber of the same nominal thickness to precisely the same thickness rough green, and fresh from the saw. Sawmills, like all other pieces of manufacturing equipment, yield products which vary in size. Successive 4/4 boards from even the best sawmill will vary in thickness from board to board. This is to be expected and accepted. It is just as true, however, that the boards need not vary over a wide range in thickness. The variation can be controlled within reasonable limits if the sawmill is operated correctly.

From the results of a study, it was concluded that the average small circular mill properly maintained and properly operated could be expected to produce at least 96 per cent of its boards within plus or minus an eighth of an inch from the average, or within a total thickness range of $^1/_4$ inch. The minimum thickness for each size cut would, of course, be that mutually agreed upon between the producer and the purchaser of the lumber. This will, in most cases, be based on American Lumber Standards for softwoods, or standards of the National Hardwood Lumber Manufacturers Association for hardwoods.

At one mill with which the authors are familiar, when use of gages described in the Handbook was started, 30 per cent of the pieces produced were indicated to be outside the control limits. Within a few weeks, however, by application of measures such as those recommended in subsequent sections of this Handbook, the percentage of unacceptable pieces was reduced to 3 per cent.

It cannot be overemphasized that the only way to assure that a sawmill is producing well-manufactured lumber is to maintain constant vigilance over the thickness of the product. Setworks readings often cannot be depended upon as a guide to the thicknesses being produced. This is especially true when the mill gets a little old, and vital parts become worn. This Handbook indicates some of the most important causes of miscutting, and provides clues to the particular causes that are operating when thickness measurements reveal mismanufacture to be present.

Proposed Standards Available for Comment

Single copies of the following tentative standards are available free of charge for the purpose of eliciting comments.

Class 5 Interference-Fit Screw Threads—A tentative trial standard, this proposal provides dimensional tables for internal and external interference-fit threads in the coarse-thread series from $^1/_4$ in. to $1^1/_2$ in. in diam. Issued for trial and comment. Available from ASME.

Pallet Sizes—This tentative standard lists 12 sizes of pallets having maximum efficiency and interchangeability, together with a substantial appendix describing background of the choice. Available from the Society of Industrial Packaging and Materials Handling Engineers, 111 West Jackson Boulevard, Chicago, Ill.

Actions of ASME Executive Committee

At a Meeting at Headquarters, Jan. 4, 1957

A MEETING of the Executive Committee of the Council, The American Society of Mechanical Engineers, was held in the Society rooms, New York, N. Y., on Jan. 4, 1957. There were present: William F. Ryan, chairman; F. L. Bradley; C. E. Crede; A. C. Pasini; and V. Weaver Smith, of the Executive Committee; J. L. Kopf, treasurer; E. J. Kates, assistant treasurer; Past-Presidents J. W. Barker and D. W. R. Morgan; Vice-President W. H. Byrne; Director Joseph Pope; C. E. Davies, secretary; O. B. Schier, 2nd, deputy secretary; D. C. A. Bosworth and T. A. Marshall, Jr., assistant secretaries; Ernest Hartford, consultant; and W. F. Thompson, ASME representative on United Engineering Trustees, Inc., and chairman of UET Real Estate Committee.

The following actions are of general interest:

Society Policies. On recommendation of the Organization Committee, the Executive Committee approved a statement, "Society Policies Adopted by the Council." Each policy action of the Council is to be given a serial "P" number and reproduced for insertion in ring binders. The policy it cancels, if any, will be stated; the Secretary will maintain an official binder of Council policies and as many additional binders as may be necessary for use of the Council, Society committees, and the Secretary's office; copies of individual policies are to be available for distribution on request, and a list of them will be included in ASME Manual MM-1, "Certificate of Incorporation, Constitution, By-Laws and Rules." [It is planned to issue a new edition of Manual MM-1, including the policies, at an early date.—Editor.]

Board on Honors. Approval was voted of a delegation of authority to the Board on Honors (*a*) to review and approve procedures of operation of the Medals Committee and (*b*) to review from time to time the activities of the Medals Committee to determine whether the committee personnel is adequate and competent to carry out its assignments.

Definitions, Mechanical Engineer and Mechanical Engineering. On recommendation of the Board on Membership the following revised definitions were approved:

1 A Mechanical Engineer is one who, through his knowledge of mathematics, the physical and chemical sciences, practices the profession of Mechanical Engineering, which is the art and science of generating, transmitting, and utilizing heat, energy, and mechanical power; of the production of tools, machinery and their products; including research, development, design, testing, application, and management.

2 The profession of Mechanical Engineering is the art and science of generating, transmitting, and utilizing heat, energy, and mechanical power; of the production of tools, machinery, and their products; including research, development, design, testing, application, and management.

Reproduction of Society Publications. An agreement with the Johnson Reprint Corporation for the reproduction of the out-of-print publications of the Society was approved.

1956 Power Show. A check received from the International Exposition Company in connection with the 1956 Power Show in New York was credited to Research Reserve.

ASME Exhibits. The Secretary was authorized to provide exhibits of suitable material to be used in connection with Professional Divisions Conferences.

American Power Conference. Participation of the Society in the American Power Conference, Chicago, Ill., May 27, 1957, was approved, subject to the approval of the Board on Technology. The Board was directed to report a program of more active responsible participation by ASME Professional Divisions interested in the 1958 American Power Conference, giving particular attention to joint activity with the American Institute of Electrical Engineers.

Recruiting Practices at Society Meetings. The President was authorized to appoint a committee to develop a Society policy regarding recruitment procedures of companies during and in connection with ASME meetings.

Student Section Established. Establishment of an ASME Student Section at Southwestern Louisiana Institute was authorized.

Certificates of Award. Special certificates for 65 years of ASME membership were authorized for: Robert W. Boenig, Henry W. Carter, Frederick A. Flather, William F. Funk, Andrew Pinkerton, Walter D. Steele, and Francis D. Thomson. Certificates of award were authorized for certain retiring chairmen of Sections, and for retiring chairmen and members of Boards and Committees.

New Engineering Center. It was reported that the American Society of Civil Engineers has approved admission of the American Institute of Chemical Engineers to membership in United Engineering Trustees, Inc. This gives unanimous approval by the five societies concerned and UET. C. E. Davies, Secretary ASME, was authorized to devote a portion of his time as co-ordinator for the New Engineering Center, as requested by UET.

Hall of Fame. It was reported that arrangements have been made for the unveiling of the bust of George Westinghouse, past-president and Hon. Mem. ASME, on Dec. 1, 1957, at the Hall of Fame, New York University. The ceremony will be held jointly with Yale University for the unveiling also of a bust of Willard Gibbs. Expenses in connection with this event have been pledged by Westinghouse Air Brake Company and Westinghouse Electric Company.

Centenary, Institution of Engineers and Shipbuilders in Scotland. The President was requested to appoint representatives of the Society to attend the centenary celebration, Glasgow, June, 1957, of the Institution of Engineers and Shipbuilders in Scotland.

Deaths Reported. The Executive Committee noted with deep regret the deaths of A. E. White, on Dec. 18, 1956, Manager of the Society, 1942–1945.

Waldemar Kaempffert, on Nov. 27, 1956; Mem. ASME since 1930; science and engineering editor, *The New York Times*.

Engineering Societies Personnel Service, Inc. (Agency)

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or nonmembers, and is operated on a nonprofit basis.

In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office.

When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St	84 East Randolph St	100 Farnsworth Ave	57 Post St

Men Available[1]

Assistant Plant Manager-Chief Industrial Engineer, ME, MBA, 31; experienced administrator; industrial, process engineer, work simplification, cost reduction, time and motion study, incentives, materials handling, plant layout, inventory control, economic lot size; ten years' experience. Prefers East Coast. ME-355.

Assistant or Plant Manager, BME, 38; six years aircraft engine manufacture, ten years pump and paper design, installation, and manufacture of tissue papers. Prefers New York metropolitan area. ME-356.

Plant Engineer, BS in general engineering, 54; 26 years' experience in steel, chemical, paint and powder manufacturing in positions as testing engineer, chief engineer of maintenance and assistant maintenance superintendent, and power plant supervision and test. Prefers Southeast. ME-357.

Plant Engineer, Maintenance Engineer, BSME, 27; one year supervisory maintenance engineer, nylon manufacture; one half year transport vehicle design and test engineer; three and one half years U. S. Navy, engineering, damage control, and repair officer aboard a diesel and steam propelled vessel, ship superintendent in yard; one year service engineer, power plant equipment; one year production and maintenance engineer, steel mill. Prefers Fla. or South. ME-358.

Chief Engineer or equivalent, BSME, 30, PE; nine years' unusually broad and well rounded experience background, experience and demonstrated effectiveness in organization, direction, and supervision of large programs. Prefers Pacific Northwest, Northern U. S. ME-359.

Mechanical Engineer, BSME, MME, 29; three years' design, field liaison, gas turbines (supervisory capacity), two and one half years' inspection field erection of machinery, piping, two years' piping and equipment analysis and design. Desires Europe. ME-360.

Industrial Engineer, B of AE, M of IE, 30; ten years' diversified experience in construction, design, production management, and sales. Prefers Northeast, West, or Southwest. ME-361.

Factory Manager, BSME, 33; nine years' experience in the design and manufacture of mechanical, electromechanical, and electronic equipment. Not heavy on theory but on getting things done. Prefers East. ME-362.

Project Engineer, mechanical; 34; ten years' tool designing, process planning, and supervising designers, etc. Approving, placing, and procuring tooling on all kinds of projects. Location immaterial. ME-363.

Project Engineer, MS (ME), 39; 14 years' experience in all phases of design and development of electromechanical devices including broad background of shop experience, production methods, and drafting. Proved ability to supervise engineeers. Prefers New York metropolitan area. ME-364.

[1] All men listed hold some form of ASME membership.

Positions Available

Teaching Personnel, department of mechanics. BS in engineering required; master's degree preferred. No teaching or industrial experience necessary. $4000-$6500; nine months; rank and salary dependent upon qualifications. Southwest. W-4258.

Sales Engineering Trainee, recent graduate, 24-30, for training in pump application work for a period of nine to 12 months; will then be assigned as office sales application engineer. Ultimately will become field sales engineer in the line of application and sales work. To start, $5100-$5700, plus fringe benefits. Participation in bonus plan after successful training period. Pa. W-4298.

Supervisory Design Engineer, graduate mechanical, minimum of ten years' in design engineering, and specifications, for power plants, distribution piping including stress analysis, with knowledge of design and selection of prime movers for chemical and petrochemical processes. Will be responsible for technical and administrative supervision of personnel; for solution and completion of design problems in mechanical piping, equipment specifications, and selection of equipment, etc. Travel about 20 per cent of time. Salary open, plus fringe benefits. Headquarters, New York, N. Y. W-4368.

Industrial Engineer, 35–45, to install new time study system in heavy machine shop operation. Plant employs approximately 2000 people. Will also institute new wage incentive plan. To $10,000. Northern Mass. W-4370.

Plant Engineer, mechanical graduate, eight to ten years' experience for central engineering staff of large multiplant operation in the food process industry. Must know water, piping, air conditioning, ventilation, etc. Some design as well as field work. To $12,000. Minn. W-4372(a).

Director of Engineering, under 50, to be entirely responsible for all engineering on small rotating electromechanical equipment, small commercial gears and transmission devices. $18,000. Northern N. J. W-4374.

Instructor in mechanical engineering, PhD or MS degree, to teach undergraduate mechanics and thermodynamics. Recent research experience desired. Salary and rank open, depending upon experience. Position starts fall, 1957. Pa. W-4383.

Project Engineer, BS or better in chemical or mechanical engineering from a recognized college, with sufficient experience to have acquired mature judgment and broad knowledge of the plastics manufacturing field. Will act in advisory capacity to management of two affiliated companies in the plastics field. One company is in packaging field. The other company fabricates thermoplastic items including lamination and printing operations. Will co-ordinate activities with production, purchasing, estimating, and sales functions through operating management. Salary open. N. J. W-4387.

Engineers for foreign operations. *(a)* Production engineers, graduates, with some industrial engineering knowledge. Approximately two years training in stateside fabricating plants for placement as superintendents in overseas plants. *(b)* Installation engineer to supervise installation of fabricating equipment and to train crews in the proper use of equipment in new plants. *(c)* Mechanical engineer to handle design of steel mill production equipment and fabricating plants. Salaries open. Headquarters, Eastern United States. F-4393.

Chief Mechanical Engineer, graduate, at least eight years' design and product engineering experience covering heavy gears, machinery, brakes, or allied power transmission equipment. $8000-$12,000. Midwest. W-4400(a).

Materials-Handling Engineer, graduate mechanical or industrial engineer, 25-40, will consider older man; a minimum of four years' experience in industrial materials handling methods, covering all phases from receipt of raw materials through processing to and including packaging. About $7440. Newark, N. J., area. W-4401.

Development Engineer, Food Products, preferably mechanical, considerable experience in laboratory development of containers and packaging. Must be good administrator to head up department of 150 people. $10,000-$15,000. Company will pay fee. Midwest. W-4404.

Assistant to Chief Engineer, not over 45, experience in the design and erection of heavy machinery, i.e., bulk conveyers, bucket ele-

vators, and the like. To $12,000. Midwest. W-4411.

General Engineering Manager, mechanical or electrical graduate, at least ten years' senior project engineering and staff-managerial experience covering electronic instruments and devices. $15,000–$20,000. Ohio. W-4414.

Engineers. *(a)* Research and development engineer, 30–45, graduate mechanical, about ten years' experience and electrical background, to head up a group doing electrical research and development on new home appliances. $10,000. *(b)* Woman engineer, graduate electrical or mechanical, with some leaning towards home economics, for an electrical appliance manufacturer. Will contact home economic groups, investigate new products, etc. This is a new and challenging opportunity with the company. Salary open. East. W-4416.

Engineers. *(a)* Chief tool engineer, eight to 20 years' experience; thorough knowledge of tool design, plant layout, and process and methods. Must be all around production man with good experience. About $13,000. *(b)* Production control supervisor, up to ten years' experience in production control; must be capable of handling supervisory responsibilities. Good experience in precision machine shop operations desired. About $10,000. *(c)* System and methods analyst with two to five years' experience and some accounting education or experience, preferably in the system and methods field. $5000–$6000. Conn. W-4435.

Engineers. *(a)* Truck engineers, 30–40, graduate mechanical, from designers to group leaders, experience in motor truck design, i.e., bodies, chassis, suspension brakes, etc. $9000–$12,000. *(b)* Bus engineers, 28–42, from designers to group leader, with experience in design of bodies, chassis, brakes, or suspension for busses in passenger service. $9000–$12,000. Eastern Pa. W-4437.

Plant Engineer, mechanical or electrical engineering training, printing-press operation and installation experience, including electrical equipment and controls. Some traveling. $6000–$10,000. New York, N. Y. W-4439.

General Manager, to take charge of engineering and manufacturing and development of company manufacturing heaters and air conditioning equipment for aircraft. Must be good administrator and have a knowledge of Government specifications and contracts. Salary open. Midwest. W-4442.

Mechanical Engineers. *(a)* Apparatus design, graduate mechanical, with two to four years' experience in the design of machinery, preferably textile machinery. Design will include conception of form and shape, production of layout drawings, and direction of the preparation of detailed manufacturing drawings and assembly drawings. $6000–$7500. *(b)* Senior engineer, apparatus design, graduate mechanical, four to seven years' experience in the design of textile machinery. $6900–$8700. Company pays placement fees. Ga. W-4445.

Director of Sales, over 40, graduate mechanical engineer or equivalent, for a manufacturer of freight passenger elevator equipment. Broad background and experience in the marketing operation including research and analysis; sales planning and implementation; merchandising and advertising in the capital goods industry. Breadth of experience in one of the following is required: metal products; hydraulic or electric hoisting lifting equipment; freight passenger elevators, or a line related to the handling/movement of products in manufacture, storage, and shipping. $12,000, plus company benefits, overriding bonus, and eventual stock participation. Headquarters, Pa., with periodic travel U. S. markets. W-4446.

Safety Engineer, graduate mechanical, to 40, with ability to plan and organize safety program for multiplant manufacturer involving heavy metal-working and fabricating operations, with large personnel. Must have had substantial safety experience in large plants. $12,000. Headquarters, New York, N. Y. W-4448.

Manufacturing Engineers, 30–45, graduate mechanical or industrial, five or more years' industrial or manufacturing-engineering experience, preferably in the area of heavy machinery and fabrication, machinery welding, and preferably some experience in bearing or gear reducers. Salary open. One in Kan.; one in W. Va. W-4449.

Product Engineer, young, mechanical graduate design and product experience on boilers, heat exchangers, or fabricated-process equipment. $6000–$7000. Central N. Y. State. W-4450.

Woodworking Engineers, graduate mechanical, long practical experience in woodworking; must be able to set up machines, know correct procedures on saw filing and knife grinding and be able to make jigs, fixtures, and machine-tool attachments. Salary open. South. W-4457.

Designers. *(a)* Mechanical, at least two to three years' experience in product design of small mechanical devices such as clocks, typewriters, etc. Must have knowledge of gearing, levers, and cams. *(b)* Electromechanical, engineering graduate preferred, experienced in electromechanical design of small mechanisms, some knowledge of production methods. Will also interview applicants without college degree. $6000–$8000. Company pays placement fees. Conn. W-4471.

Overseas Engineer, mechanical degree, thorough and practical machine experience, 25–35, to bring complete knowledge of manufacturing processes to overseas operations. Overseas travel 60–80 per cent. Salary open. Headquarters, N. J. W-4472.

Manufacturing Manager, 35–45, ME or IE graduate, at least ten years' experience covering precision electromechanical devices and aircraft instruments. $20,000–$25,000. Long Island, N. Y. W-4474.

Chief Engineer, mechanical or electrical, experience in the manufacture of electromechanical products (electrical used in metering, signalling, and similar devices). Must have outstanding record as chief engineer. Salary open. R. I. W-4478.

Chief Mechanical Engineer, BS (ME) or equivalent, majoring in mechanical design and extra curriculum courses in physics and materials; about 35; eight to ten years' product design experience on electric transformers, preferably in association with the manufacture of larger type high-voltage electric transformers. Will be responsible for the functions of layout, detailing, planning, and sundry mechanical engineering services of electric transformers, both air and liquid. N. J. W-4479.

Plant Engineer, young, mechanical or electrical graduate, operating and maintenance experience in diesel power-plant and distribution experience including overhead-line construction, 2400 volts. Knowledge of Spanish desirable. $6000–$7200. Honduras. F-4482.

Quality-Control Engineers. *(a)* Statistical-engineering staff, minimum of one year's experience in television, radio, or electronics on incoming and process inspection. $6500–$7000. *(b)* Supervisor, minimum of three years' experience in television, radio, or electronics for direct supervision of quality-assurance program, spot testing, inspection of finished goods, etc. Salary open. Northern N. J. W-4490.

Design Engineer, at least five years' mechanical equipment-design experience for catapult projects. $10,000–$12,000. Eastern Pa. W-4500.

Engineers. *(a)* Plant superintendent, 30–45, degree in engineering or business administration, at least three years' practical experience in a position of equivalent responsibility in mass-production-fabrication industry using primarily metals and plastics. Will supervise an assembly plant of approximately 500 employees, with operations on a mass-production basis. Salary open. *(b)* Chief industrial engineer, 28-40, graduate in industrial engineering or mechanical engineering with emphasis on industrial engineering, at least three years' practical experience in a position of equivalent responsibility in mass-production fabrication industry using primarily metals and plastics. Will supervise all industrial-engineering activities under direction of plant manager. Emphasis will be on methods engineering, production-line layout, design of jigs and fixtures, development of work simplification program, etc. Salary open. Vicinity of Newark, N. J. W-4504.

Candidates for Membership and Transfer in ASME

THE application of each of the candidates listed below is to be voted on after Feb. 25, 1957, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications and ●Transfers

California

BURTON, GEORGE M., Venice
CHANG, HUGH C., Oakland
CONN, ROBERT G., Palo Alto
SEMARNE, HENRI M., Santa Monica
SHAPIRO, HENRY, Santa Monica
WEIRICH, RICHARD G., Torrance

Colorado

ARNETT, ROBERT W., Boulder
CONSTAM, ERNEST G., Denver

Connecticut

FREEMERMAN, RONALD L., Windsor

Delaware

GALLO, RAPHAEL E., Newark
RAMSEY, HAROLD E., Wilmington

District of Columbia

BANERJEE, SAILESH C., Washington
SEWELL, HOMER B., JR., Washington

Florida

CULPEPPER, WILLIAM B., Panama City
●HANKS, ROGER L., JR., Pensacola
LUFF, HARRY C., JR., Orlando
●PHELPS, RICHARD T., JR., Pensacola
RUTHVEN, BREMAN, Panama City

Georgia

NORTON, ROBERT R., Augusta

Illinois

ANDERSON, HERBERT W., Chicago
BROUSEK, JAMES C., Broadview
FAGAN, WALTER S., Chicago
●GOOD, LOUIS G., Skokie
●HUNT, JAMES W., Lake Bluff
IVANSKA, JOSEPH, JR., Chicago
KAPLAN, LOUIS G., Chicago
KOOYMAN, EVERT A., Chicago
KUHNKE, WILLIAM B., Chicago
MCKANNA, WILLIAM P., Lemont
OLSON, KENNETH A., Berwyn
SCHUTTE, JOSEPH P., Orland Park
YOHANA, ANDREW, Skokie

Indiana

LINCOLN, MELVIN R., Hammond
PENNELS, NORMAN E., East Chicago

Louisiana

ALEXANDER, THOMAS E., Baton Rouge
CHAUVIN, MAXWELL C., Metairie
MCELROY, WELDON W., Baton Rouge
SHANKLE, WARREN C., Baton Rouge

Maryland

BELCHER, HORACE E., Baltimore
BINGHAM, WILLIAM L., College Park
DAVISON, ROBERT W., Bethesda
RUSSELL, HUBERT E., Curtis Bay
STALEY, WILLIAM C., Baltimore

Michigan

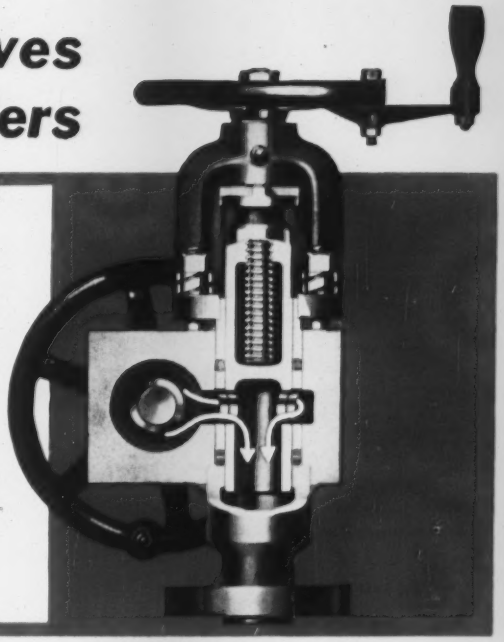
CLARK, WILLIS M., JR., Ann Arbor
HELLEM, ROBERT S., Dearborn
PYE, WILLIAM F., Detroit
RICHARDS, PAUL S., Benton Harbor
●STUCKEY, VIRGINIA M., Midland

● Transfer to Member or Affiliate.

(ASME News continued on page 218)

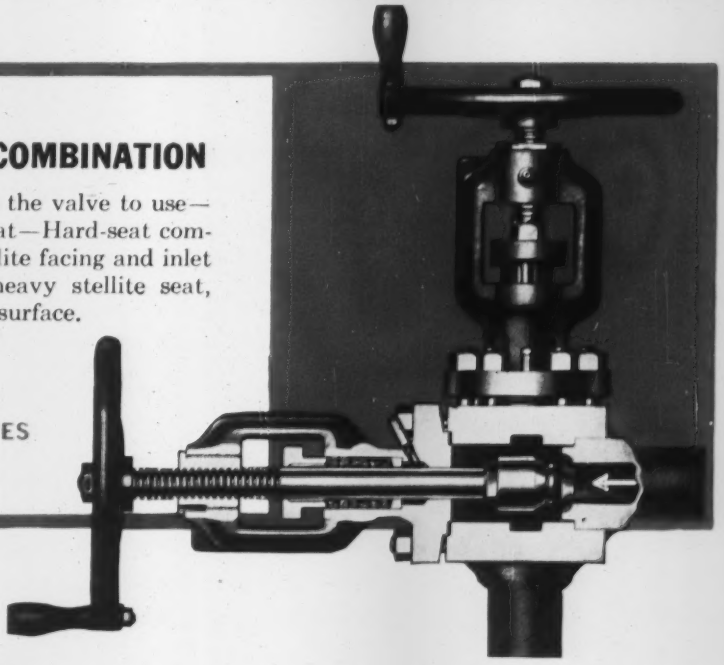
UNIT TANDEM

rugged blow-off valves for high pressure boilers



HARD-SEAT—SEATLESS COMBINATION

■ For boilers up to 1500 psi, this Yarway Unit Tandem Blow-Off Valve offers the maximum in dependable service. A one-piece forged steel block serves as the common body for the Yarway Stellite Hard-seat blowing valve and the Yarway Seatless sealing valve. All interconnecting flanges, bolts and gaskets are eliminated. The Unit Tandem at right is sectioned through Seatless Valve to show balanced sliding plunger in open position and free flow.



HARD-SEAT—HARD-SEAT COMBINATION

■ For boilers to 2500 psi, this is the valve to use—Yarway's Unit Tandem Hard-seat—Hard-seat combination. Disc has welded-in stellite facing and inlet nozzle has integral welded-in heavy stellite seat, providing smooth, hard-wearing surface.

OVER 4 OUT OF 5
HIGH PRESSURE PLANTS
USE YARWAY BLOW-OFF VALVES

Write for Yarway Catalog B-434

YARNALL-WARING COMPANY
108 Mermaid Ave., Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY BLOW-OFF VALVES

Minnesota

●Goodman, Lawrence E., Minneapolis

Missouri

●Ege, Howard D., Kansas City
Hanna, Homer J., Kansas City
Lowman, Buford J., Kirkwood

New Jersey

Antunes, Fred F., Trenton
Collins, John O., Linden
McFarlan, Edward R., Westfield
Rickles, Nathaniel H., Roselle Park
Schlamp, Walter A., Manasquan
Spalletta, Michael A., Newark
Warne, Ira B., Red Bank

New Mexico

Ahrens, R. L., Farmington
●Brazier, Emmett L., Jr., Los Alamos

New York

Bock, Jorgen, Union
●Caldwell, David F., Whitesboro
Caplan, Morton L., New York
Clark, Adelbert G., Painted Post
●Connelly, John N., Corning
●Costagliola, Michael, Sea Cliff
Dunham, Cecil L., New York
Fedan, Stephen A., New York
Fleisher, Harold, Poughkeepsie
Honigsberg, Charles A., New York
●Kohn, Julius A., Schenectady
May, Warren F., Painted Post
Paradiso, Michael A., Brooklyn
Pollack, Herman W., Brooklyn
Roukis, John G., Huntington
Smith, Melvin I., Bayside
Szerwo, Joseph M., New Hartford
Treff, Walter A., New York
Varca, Bart A., Brooklyn

North Carolina

Ruddell, Joseph P., Charlotte

Ohio

Cox, Andrew R., Cleveland
●Goldbeck, Carl W., Chagrin Falls
●Jepson, Paul D., Toledo
●Sanders, John C., Cleveland Heights
Wiggins, Jesse O., Cincinnati
Zubko, Leonard M., Cincinnati

Oregon

Dorries, Norman B., Portland

Pennsylvania

Albertson, Curtis C., Philadelphia
Awtrey, Palmer H., Greensburg
●Bradford, Dudley M., Berwick
Duncan, Lee E., Lebanon
Galan, William S., Bradford
Galimberti, James M., Jr., Latrobe
McCray, Roger M., Latrobe
Sadler, John W., Pittsburgh
●Sandt, Franklin T., Allentown
●Schmitt, Robert D., Hatboro
Schreckongost, John R., Erie
Simmons, Jean V., York
Stock, Robert J., Philadelphia
Tong, Long S., Pittsburgh
Wagstaff, Robert R., Swarthmore

South Carolina

Damkwood, Frank A., Aiken

Tennessee

Hogan, William J., Tullahoma

Texas

Atkins, George T., Baytown
●Caswell, Robert M., Texas City
French, Ray N., Baytown

Virginia

Bannerman, Robert A., Petersburg

Washington

Pare, Eugene G., Pullman

Wisconsin

Balch, James L., Madison
Bradley, Robert H., Beloit
Gibbling, Alfred H., Milwaukee
Petersen, John R., Beloit

Foreign

Barbosa, Joao F. G., Rio de Janeiro, D. F., Brasil
Benaresh, Edmond, Abadan, South Iran
Bennett, Gerald B., Downsview, Ont., Canada
Ikeshima, Toshio, Amagasaki, Japan
Mirza, Mohammed A., Hyderabad, Deccan, India
Portela, Antonio G., Lisbon, Portugal
Ristic, Vladeta S., Toronto, Ont., Canada
Suzuki-Morales, Daniel, Mexico, D. F., Mexico
Vidal, Francisco F., Havana, Cuba
Young, Harold A. P., Colombia, South America

Transfers from Student Member to Associate Member, Class of 1956 65

Obituaries

Nicholas Constantine Artsay (1889–1956), senior design engineer, steam department, Foster Wheeler Corp., New York, N. Y., died June 20, 1956. Born, Sebastopol, Russia, July 24, 1889. Education, graduate, Emperor Nicholas I Academy of Marine Engineering and Naval Architecture, Kronstadt, Russia; postgraduate mechanical-engineering course, Institute of Technology, St. Petersburg. He worked on the design and construction of battleships at the Baltic Naval Yard in St. Petersburg and was chief staff engineer of Russia's latest battleship squadron at the start of World War I. During the war he earned an admiralty rating of Colonel. He served with the White Russian Navy in the Black Sea until resistance to the communist government collapsed, when he went to North Africa. From there he shipped as a crew member on a steamer bound for the United States. Naturalized U. S. citizen. Mem. ASME, 1947. Held several patents pertaining to steam generation, which were assigned to Foster Wheeler Corp. A widower, Mr. Artsay is survived by a son, Constantine, of Valhalla, N. Y.; two grandchildren; and a sister.

William Howard Clapp (1874–1956), professor of materials and machine design, California Institute of Technology, whose death was recently reported to the Society. Born, Bedford, Ohio, July 4, 1874. Parents, Edward Kent and Emma (Schramm) Clapp. Education, University of Minnesota, BS (ME), 1901. Married Mary S. Allis, 1904; two sons, George Wirt and Roger Delancy. Author of several technical articles and holder of patents on crushing rolls, a centrifugal quartz mill, oil-well swivel, and oil-well pump. Mem. ASME, 1914, served three times on Executive Committee of his local Section.

Everett Michael Cloran (1905–1956), research and consulting engineer, College of Engineering, University of Southern California, died Sept. 27, 1956. Born, Cambridge, Mass., March 12, 1905. Parents, Michael James and Mary Ann Cloran. Education, BS (ME), Harvard University, 1928. Married Alice Honora Comes, 1933; children, Alice Ann and Michael J. C. Author of several technical papers and holder of patents on fluid-metering devices. Mem. ASME, 1945.

Edgar Ogle Dixon (1894–1956), vice-president in charge of research and metallurgy, Ladish Company, Cudahy, Wis., died Nov. 4, 1956. Born, Chicago, Ill., May 3, 1894. Education, attended University of Illinois, 1917–1919. Author, jointly with Frey Benton, of "Heat Treatment of Carbon Steel," for the Metals Handbook, 1939. Mem. ASME, 1940.

Sidney George Down (1876–1956), retired former vice-president, Westinghouse Air Brake Company, Wilmerding, Pa., died at San Diego, Calif., Oct. 7, 1956. Born, Swansea, Wales, Jan. 1, 1876. Parents, Richard and Annie (Button) Down. Education, attended Detroit Engineering School, hon. DE, Clarkson College of Technology. Held 73 patents covering air-brake apparatus and control apparatus for oil-burning boilers. Mem. ASME, 1950.

Joel Eklund (1887–1954), steam power plant engineer, U. S. Rubber Co., New York, N. Y., whose death was recently learned of by the Society, died in 1954. Born, Ronneby, Sweden, Jan. 9, 1887. Technical school education in Sweden. Mem. ASME, 1925. Survived by Mrs. Eklund.

Joseph F. Geers (1884–1956), director and former president and general manager, Index Machinery Corp., Cincinnati, Ohio, died Feb. 9, 1956. Born, New Alsace, Ind., April 24, 1884. Grade and high-school education. Mem. ASME, 1929.

Edwin Gardner Greenman (1881–1956), chief engineer, Norton Door Closer Company, Chicago, Ill., died Sept. 4, 1956. Born, Taylorville, Ill., April 28, 1881. Parents, Edwin and Carrie Hoose (Paine) Greenman. Education, BS (ME), University of Illinois, 1902; ME, 1907. Married L. Pearle Brownell, 1904; children, Paul H., Robert B., Clarence P., Hugh M., Edwin G. Jun. ASME, 1907; Mem. ASME, 1913.

Lewis Tompkins Hays (1884–1956), who retired from Columbia Steel Co. in 1949 after 43 years of continuous service with United States Steel Subsidiaries, died Oct. 15, 1956. Born, Morristown, N. J., Oct. 1884. Education, attended Pratt Institute, 1904–1906. Married Elizabeth Gillmore Hayes, 1915 (died 1927); children, Janet Hays Livermore, Lewis Tompkins Hays, Jr. Married 2nd, Verna Nichols Hays, 1928. Assoc. Mem. ASME, 1916; Mem. ASME, 1918.

John W. Kittredge (1869–1956), retired machine designer for M. H. Rhodes, Inc., Hartford, Conn., died in Warren, Ohio, July 26, 1956, where he had resided since 1950. Born, Charlton, Iowa, March 26, 1869. Parents, Charles W. and Charlotte (Mahon) Kittredge. He was graduated from Massachusetts Institute of Technology in 1894. Married Anne Lois Atkinson, 1900; sons, Samuel M. (died 1903) and Severn W. Assoc. Mem. ASME, 1916; Mem. ASME, 1935. Survived by his son, of Warren, Ohio.

Gleason Harvey MacCullough (1895–1956), professor and head of the department of mechanical engineering, Worcester Polytechnic Institute, died Oct. 15, 1956. Born, Sawyerville, Que., Canada, of American father, Sept. 9, 1895. Parents, Robert and Florence (Harvey) MacCullough. Education, MS, Worcester Polytechnic Institute, 1931; DS, University of Michigan, 1932. Member, Sigma Xi and Tau Beta Pi. Author of several technical papers on creep, and coauthor with S. Timoshenko of "Elements of Materials," 1935. Jun. ASME, 1921; Assoc. Mem. ASME 1926; Mem. ASME, 1930; served on ASME Committee on Symbols for Mechanics.

Robert Bedford Pogue (1889–1956), consulting engineer and former vice-president for engineering, Brake Shoe and Castings Division, American Brake Shoe Co., Mahwah, N. J., died Sept. 26, 1956, at West Orange, N. J. Born, Mayflack, Ky., May 7, 1889. Education, BS (ME), University of Kentucky, 1913; MS, University of Illinois, 1915. Except for a year of military service in World War I, his entire career was with American Brake Shoe Company, where he began as an apprentice inspector in 1916. Mem. ASME, 1947.

Nathan Ransohoff (1887–1956), chairman of the board and chief engineer, N. Ransohoff, Inc., Cincinnati, Ohio. Born, Cincinnati, Ohio, Nov. 25, 1887. Parents, Joseph and Minnie F. Ransohoff. Education, BS (ME), Massachusetts Institute of Technology, 1910. Married Martha Beckman, 1916; sons, Jerry N., William, and Daniel J. Author of several technical papers and holder of more than 25 patents on metal-processing machinery. Jun. ASME, 1912; Assoc. Mem. ASME, 1921; Mem. ASME, 1921.

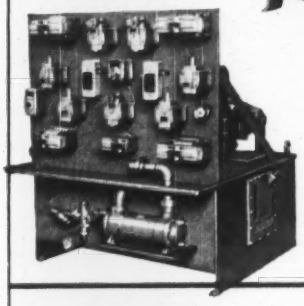
Robert John Remer (1923–1955), design group leader, Dryer Engineering Division, Procter & Schwartz, Inc., died at Philadelphia, Pa., in November, 1955. Born, Philadelphia, Pa., Sept. 20, 1923. Education, BS (ME), Drexel Institute of Technology, 1947. Jun. ASME, 1947.

Peter Theodore Reuter (1898–1956), manager, Boston District Office, Bailey Meter Co., died Oct. 5, 1956. Born, Carlos, Minn., Nov. 9, 1898. Education, BS (ME), University of Minnesota, 1921. Mem. ASME, 1945. He is survived by his wife and three daughters.

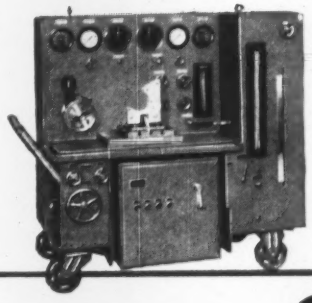
George Webster Saathoff (1884–1956), consulting engineer and specialist in power-plant construction, died Nov. 10, 1956, at Sea Girt, N. J. Born, Litchfield, Ill., July 22, 1884. Education, BS (EE), University of Illinois, 1906. Married Olive (Howell) Saathoff. Mem. ASME, 1922; Fellow ASME, 1946. After a period of training with the Westinghouse Electric and Manufacturing Co., Pittsburgh, Pa., he joined the Cities Service Co., with which he remained

(ASME News continued on page 220)

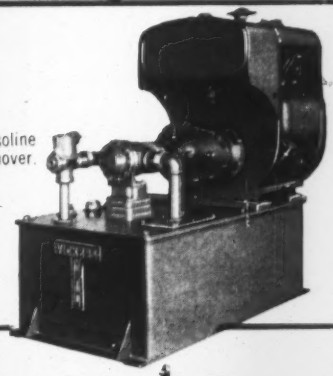
Pulpit type power unit provides full visibility, easy accessibility.



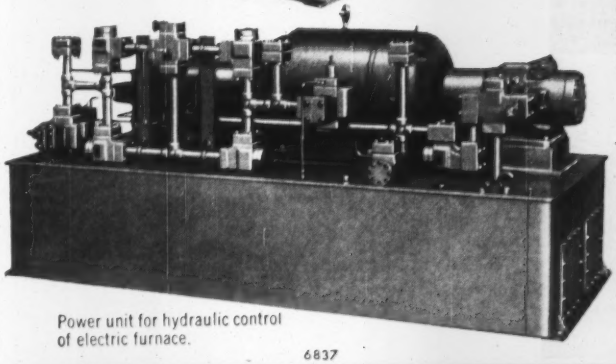
Compact power unit showing gasket-mounted valves.



Portable power unit for testing pumps.



Power unit with gasoline engine as prime mover.



Power unit for hydraulic control of electric furnace.

6837

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HYDRAULIC POWER UNITS

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BETTER APPEARANCE

Vickers engineers approach the design of a custom-built hydraulic power unit from the standpoint of the customer's INDIVIDUAL needs. The sole objective is to meet HIS requirements with the best hydraulic "package". This assures the most compact, efficient and convenient hydraulic equipment for the particular machine.

A Vickers Hydraulic Power Unit includes all necessary pumps, valves, intermediate piping, oil reservoir, motors, controls, etc., as well as all hydraulic accessories (oil filters, air cleaners, oil level gauges, fittings, etc.). Hydraulic connections can be grouped in a convenient manifold.

In addition to the advantages mentioned above, each Unit is pretested at the factory and ready for immediate operation. Vickers undivided responsibility for the entire hydraulic control system is also an important feature to both the machine builder and his customer. Write for Bulletin 52-45.

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ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

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From the master file are made the lists of members registered in the Professional Divisions. Many Divisions issue newsletters, notices of meetings, and other materials of specific interest to persons registered in these Divisions. If you wish to receive such information, you should be registered in the Division (no more than three) in which you are interested. Your membership card bears key letters, below the designation of your grade of membership and year of election, which indicate the Divisions in which you are registered.

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Date

LAST NAME FIRST NAME MIDDLE NAME

POSITION TITLE
e.g., Design Engineer, Supt. of Construction, Manager in Charge of Sales, etc.

NATURE OF WORK DONE

NAME OF EMPLOYER (Give complete name in full)

Division, if any

* ☐
EMPLOYER'S ADDRESS City Zone State

ACTIVITY, PRODUCT, or SERVICE OF EMPLOYER: e.g., Turbine Mfrs., Management Consultants, Oil Refinery Contractors, Mfr's. Representative, etc.

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☐ G—Safety	☐ P—Petroleum	☐ Z—Instruments and Regulators
☐ H—Hydraulics	☐ Q—Nuclear Engineering	

for 35 years. He was vice-president and director of Electric Advisors, Inc., a subsidiary of Cities Service, until 1946 when he started his own business. He is survived by his wife; a daughter, Mrs. Ralph H. Davis, Lexington, Mass.; a son, George T. Saathoff, Madison, N. J.; two brothers, Harry and John Saathoff of Litchfield, and ten grandchildren.

DeWitt McClure Taylor (1883–1956), mechanical engineer, Johnson & Moreland, Boston, Mass., and former associate editor of *Power*, died Nov. 13, 1956. Born, Pittsburgh, Pa., Sept. 8, 1883. Education, BS, Massachusetts Institute of Technology, 1906. Assoc. Mem. ASME, 1914; Mem. ASME, 1920.

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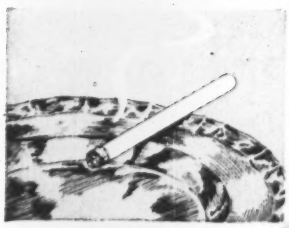
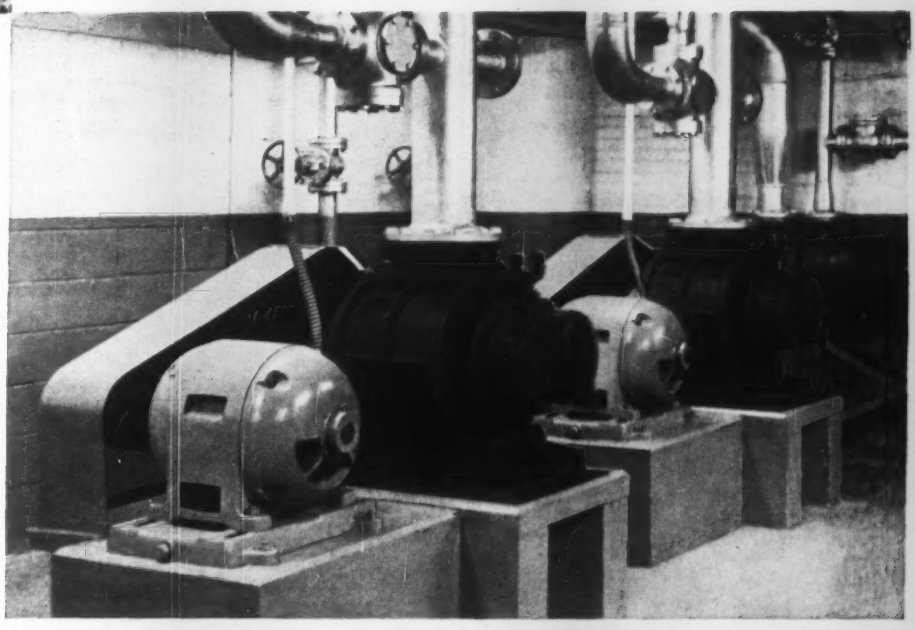


For R. J. Reynolds Tobacco Company



R-C blowers deliver clean air for processing

In the modern Winston-Salem, North Carolina plant of this leading tobacco company, process air and vacuum are supplied to cigarette making machines from a central system utilizing Roots-Connersville blowers and vacuum pumps.

As in a food plant, cleanliness is of utmost importance. The process air delivered by the R-C blowers is clean, dry, uncontaminated. Operating without internal friction, these blowers need no internal lubrication to maintain high efficiency. Only external bearings and gears require oil. Air is delivered free of oil vapors and moisture—as clean as it enters the blower.

This is only one of the many performance-proved advantages of these famous blowers . . . and one of many reasons they are used to handle air or gas in hundreds of applications throughout industry. Experienced R-C engineering service for any product or process application is yours for the asking. For complete engineering data, write for Bulletin RB-154.

R-C equipment purchased for this installation

Two 10 x 15 Blowers each rated 975 scfm, 14.7 psia inlet, 20 psia discharge, 605 rpm, 36 Hp.

•

Three 10 x 18 Vacuum pumps each rated 735 scfm with inlet at 18" Hg vacuum.

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NAME OF EMPLOYER (Give complete name in full)

Division, if any

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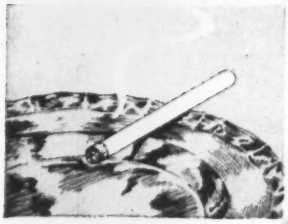

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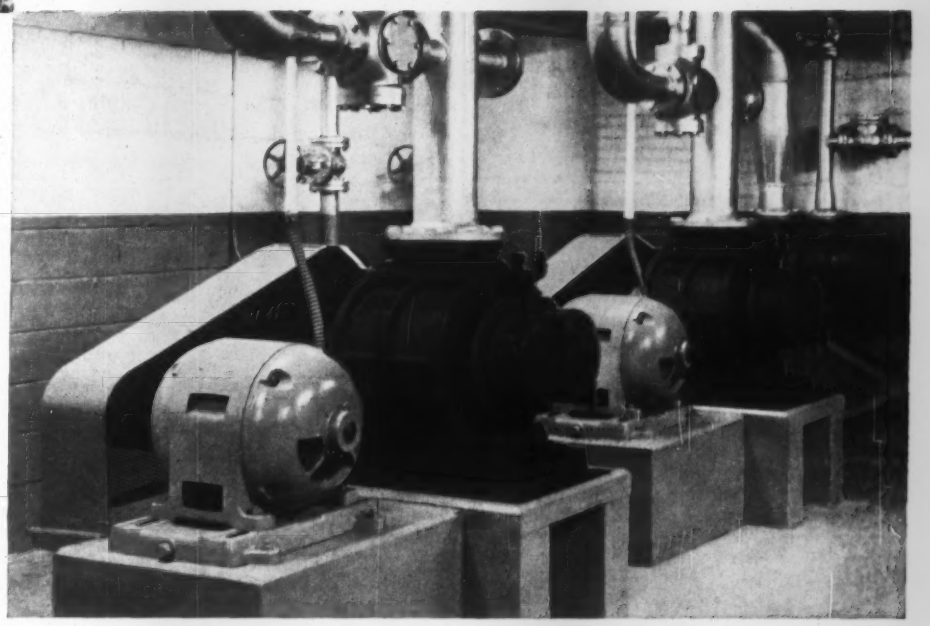

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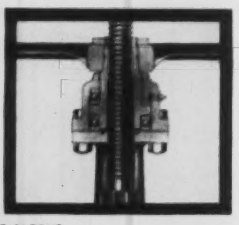
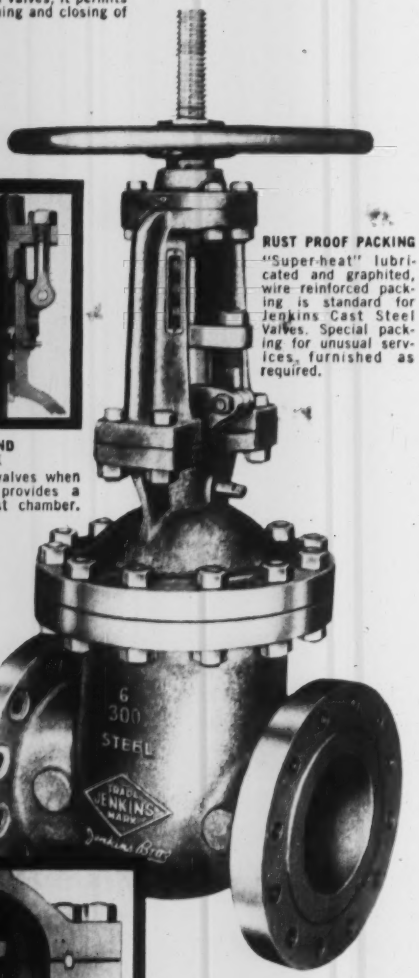
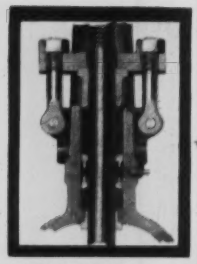


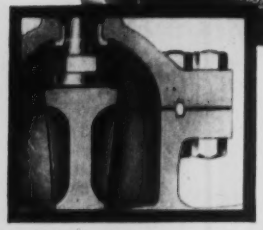
BALL BEARING YOKE SLEEVE
Standard on larger sizes of all 300, 400, and 600 psi Cast Steel Valves, it permits easy opening and closing of valve.



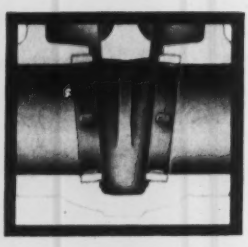
RUST PROOF PACKING
"Super-heat" lubricated and graphited, wire reinforced packing is standard for Jenkins Cast Steel Valves. Special packing for unusual services, furnished as required.



LANTERN GLAND STUFFING BOX
Furnished in valves when specified, it provides a cooling or test chamber.



STEEL RING GASKET
All 400 and 600 psi Valves are furnished with soft steel ring joint body-bonnet gasket, fitted into accurately matched grooves, assuring a lasting, vapor-tight joint.



THROUGH PORT GATE DESIGN
Wedge lifts out of flow when valve is full open, permits free, unobstructed flow.

for design features that deliver
top-rated efficiency . . . lasting economy

JENKINS CAST STEEL VALVES

The details shown are only a few of the many design features developed by Jenkins valve specialists to make Jenkins Cast Steel Valves a match for the most punishing requirements of higher pressure, higher temperature services.

You can get the required combination of casting alloys and seating metals for services up to 600 psi — 1000°F. With any valve specified, you get the *plus* of Jenkins *extra value*, — in performance, in lasting economy.

Compare every feature, and you'll see why Jenkins Cast Steel Valves are first choice for so many systems planned for lowest operating cost.

PATTERNS	Gates 2" to 24" — Globes 2" to 10" — Angles 2" to 10" — Swing Checks 2" to 12". Non-return, stop and check Globes and Angles, 4" to 10" Screwed, Flanged, or Weld Ends
PRESSURES	150 lb. — 300 lb. — 400 lb. — 600 lb.
PRESSURE CASTING ALLOYS	Carbon Steel — 150 lb. Valves Carbon Molybdenum Steel — 300, 400, 600 lb. Valves Chromium Molybdenum Steel (when ordered)
SEATING METALS (in various combinations)	H Monel 13% Chromium Stainless Steel Carbon Molybdenum Steel, Stellite faced AISI Type 316 Stainless Steel

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NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Available literature or information may be secured by writing direct to the manufacturer. Please mention MECHANICAL ENGINEERING.

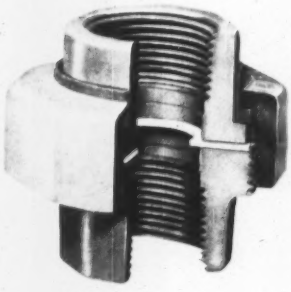
NEW EQUIPMENT

Solvent Resistant Grease

Pennsylvania Refining Co., Cleveland 4, Ohio, announces a new type of grease made especially to overcome the problem of solvents washing away pump lubricants.

The company's new solvent resistant grease is said to be impervious to the washing action of almost all petroleum and chlorinated solvents. The firm says it is not affected by naphtha, kerosene, gasoline, LP gas, fuel oils, coal tar solvents, trichlorethylene, perchlorethylene, and orthodichlorobenzene.

Another feature of the lubricant is that its consistency remains relatively unchanged in use and it may be pumped readily in a hand grease gun at extremely low temperatures, the company states.

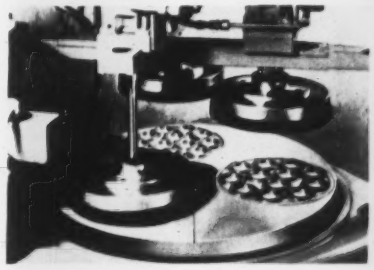


Insulating Union

Insulating forged steel unions, used to prevent electrolytic corrosion due to flow of electric current along pipe lines, are now available from W-S Fittings Division, H. K. Porter Co., Inc., Roselle, N. J.

The unions are manufactured in 3000 lb class, sizes $^1/_4$ to 3 in. in screw-end and socket-welding types.

The tailpiece, thread piece and nut are drop forged from carbon steel in accordance with ASTM material specification A-105 Grade 2. The insulating sleeve separating the tail piece and nut is made of fabric-reinforced phenolic resin. The gasket which seals the union joint, and which is in contact with the fluid in the pipe, is made of Teflon.



Lapping Machine

Production polishing accessories and equipment are now available from Crane Packing Co., Dept. MXN, 6400 Oakton St., Morton Grove, Ill., for conversion of the Model 24 Lapmaster lapping machine into a high speed polishing unit.

Tooling consists of a special lap plate and pneumatic lifts. Also added are sponge neoprene pads to the pressure plates, 4/0 polishing paper discs and double sided sensitive tape for mounting the polishing paper to the lap plate. Conversion can be readily accomplished in the plant, the company states.

Using the 4/0 polishing paper, the machine is especially recommended by the company for parts requiring low RMS finishes. It is said to assure a high production rate without generating heat to distort parts. Flatness can generally be held under 3 light bands. Typical materials, together with finished polish readings are: Soft steel (to 3-4 rms) and hard steel, stainless steel and brass (to 2 rms).

To obtain closer finish, as well as polishing parts such as carbon, glass filled Teflon, Bakelite and similar materials, an alloy polishing plate would generally be recommended by the company.

Combustion System

Dravo Corp., Pittsburgh 25, Pa. has entered the municipal and industrial incineration field with the development of an odorless, smokeless and continuous combustion system for disposal of refuse materials.

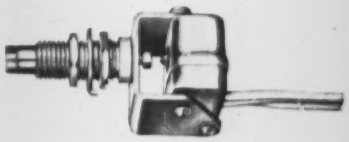
In a bulletin, No. 1506, the firm describes its "Continuous Flow" incinerator as a completely integrated unit, adaptable for installation on any site and in many existing structures. The unit includes receiving pits, automatic refuse handling conveyor, traveling grate stoker, a water-wall furnace, fans, wet-type gas scrubber, residue discharge convevor, ductwork, walkways, motors, gauges and operating controls.

Slinger-Ring Fan

A new series of ten-bladed slinger-ring fans announced by Torrington Mfg. Co., Torrington, Conn., is designed to save about one inch of axial depth in room air conditioners while matching air-flow performance of the commonly used six-bladed fans.

The company claims that unit cost can be lessened by the reduced unit depth permitted by this fan. A one-piece, five-bladed slinger-ring series is also available.

Both the C13-10 ten-bladed series and the C13-5 five-bladed series have a slinger ring outer diameter of $14^1/_4$ in. and are as low as $1^{19}/_{32}$ in. in axial depth. Several slinger ring positions are available. The blades and slinger ring are aluminum; and the hub may be aluminum, steel, rubber-bushed, or rubber bonded. Finishes are mill finish on aluminum and zinc plating on steel. All fans are statically balanced.

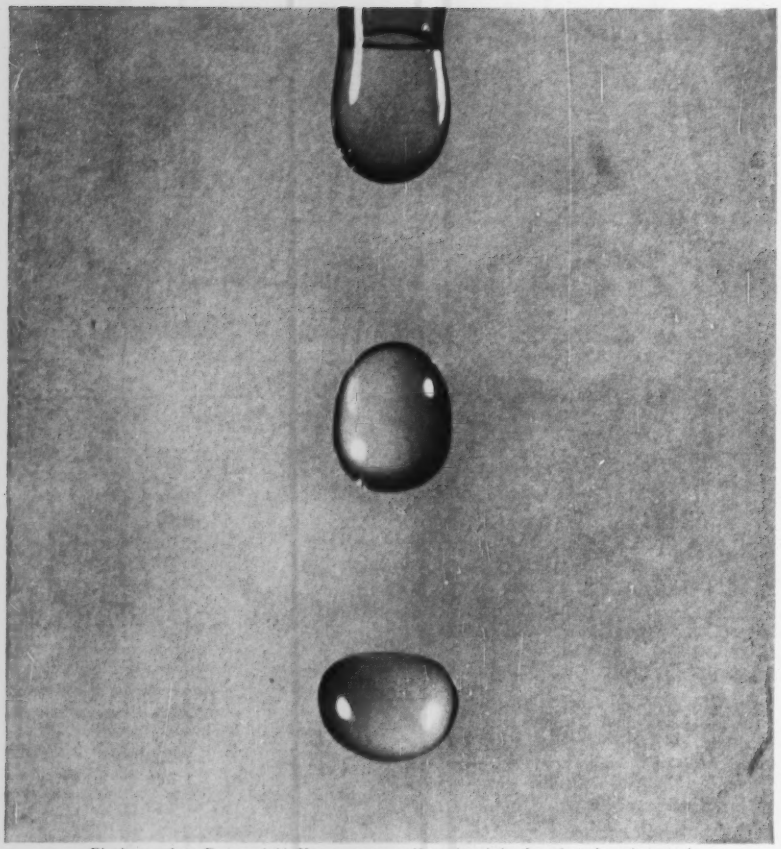


Hermetically Sealed Switch

Haydon Switch, Inc. Waterbury, Conn., announces a new hermetically sealed potted switch complete with actuator. Primarily for use on aircraft and missile applications, this hermetically sealed switch will operate under the most trying environmental extremes, the company claims.

A threaded actuator plunger guide sleeve permits mounting the switch actuator button flush or extended any distance from the mounting board up to $^3/_4$ in. The switch is hermetically sealed, filled with dry, inert gas and is moisture and dustproof.

Switch No. 9129, mounted on actuator, has $^1/_8$ in. overtravel with $^1/_8$ in. pretravel along the plunger. Switches tested have passed the 50G shock MIL specification, the firm states. The actuator button is compounded from special elastomers that will flex satisfactorily at −90 to +285 F. The switch is bonded to the switchcover and will withstand 100 psi pressure differential inside to outside without rupture or leak.



Photographer Bernard Hoffman uses a tiny droplet of water, forming and falling, to illustrate time sequence.

Controlling Time in Fluid Engineering

Even in simple hydrodynamic situations like the one pictured above, time sequence is measured in micro-seconds. More often than not, other factors – such as pressure, volume and flow – all tend to complicate fluid time control. That's where the engineering leadership of S. Morgan Smith can help you most.

SMS Rotovalves, for example, will give you the closest control of closing time . . . as quick as one second or as slow as needed. Their fast initial shut-off limits reversal of flow, and closure is positive and drop-tight. Rotovalves are easier to operate, requiring less power for mechanical or electrical operation, and their full line opening means less head loss and lower pumping costs.

SMS offers you a complete line of standard Rotovalves, Ball Valves and R-S Butterfly Valves, as well as special application engineering help. To obtain full information, call our nearest representative, or write S. Morgan Smith Company, York, Penna.

S. MORGAN SMITH HYDRODYNAMICS

AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED, TORONTO

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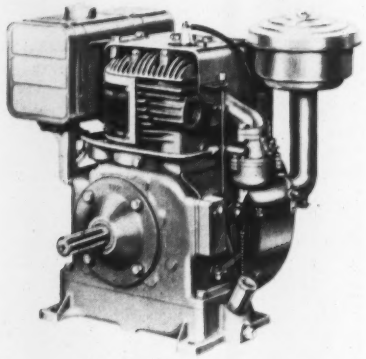

Four-Cycle Engine

A completely new 7 hp engine is being added to the line of Briggs & Stratton Corp., Milwaukee, Wis., manufacturers of single cylinder, 4-cycle gasoline engines.

The new Model 19 series engine has a 3-in. bore and 2⅝ in. stroke with a piston displacement of 18.56 cu in. It develops 7 hp at 3600 rpm.

The cylinder and crankcase are made of close-grained cylinder iron, while the base, cylinder head, bearing supports, piston and connecting rod are made of aluminum alloy. The weight of the unit is 78 lb. The carburetor is a concentric-float type designed to meet the special requirements of industrial engines. The governor is an adjustable, mechanical type, fully enclosed, running in oil. Lubrication is provided by a simple, fool-proof splash system, the firm states.

Ignition is provided by the firm's patented Magnematic ignition system. This ignition system is designed to provide a spark tailored to meet the engine's requirements. The breaker points, condenser, radio shielded stop switch and ground wire terminal are mounted in a box on the outside of the crankcase where it is easily accessible for servicing. The spark plug is size 14 mm.

The new model is also available in other types incorporating the following features: crankshaft mounted in two shielded ball bearings; direct mounting crankcase, machine faced and tapped with crankshaft mounted in two shielded ball bearings; 6 to 1 gear reduction; engine equipped with manually operated clutch.

Available as special equipment is a rotating blower screen to keep cuttings and foreign material out of the engine cooling system. Other special equipment includes an electric starter-generator unit, a starting crank, remote governor and throttle controls, fuel pump, automatic choke and ignition shielding.

The firm has also redesigned its Model 23 engine to develop 9 hp at 3600 rpm instead of 8.4 hp as previously rated. This engine is known as Model 23A and is available in the various types and special equipment as is the new Model 19.

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NEW EQUIPMENT
BUSINESS NOTES
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Moly Lubricants

Molyglyde, a line of molybdenum disulfide compounds specifically designed to help solve industry's tough lubrication problems, is announced by Van Guard Solid Lubricants, Inc., 53 E. 73rd St., New York 21, N.Y.

Each product is developed with the needs of a particular industry in mind, though its applications are not limited to one field, the company reports. An example is Molyglyde No. 256-V, incorporating moly in a volatile base. Applied in the same manner as a light viscosity lubricant, the moly is conveyed to points to be protected where it volatizes, leaving the moly to function as a dry lubricant. Originally developed for use in the food and textile industries, where contamination is a vital factor, it has infinite applications in the metalworking field, the firm states.

Molyglyde No. 156-P is a multi-duty lubricant designed for general use (where heat above 300 F is not a factor) in maintaining capital equipment, materials handling and trucking machinery (fifth wheel of trailers, shackle bolts, leaf springs). Other applications in plant operations, maintenance and end products are also possible with this lubricant, the company says.

Brush Cleaning Unit

Enterprise Machine Co., Box 112, New Castle, Del., announces the Brush-Flush, a double filtering tank unit for parts cleaning, designed for use in automotive and aviation repair shops, factories, machine shops and printing shops.

The main tank dimensions are 20 × 20 × 4 in. Capacity is 2 to 3 gal. The unit has a $^1/_{25}$ hp motor and operates on 115 v, 60 cycle a.c.

Chain Conveyor

Announcement of a newly developed corner, adjustable to 180 deg turn on as small as a 5 in. radius, for horizontal turns and vertical turns to 128 deg has been made by Chain-O-Flex Corp., 3334 Lincoln Ave., Franklin Park, Ill.

Through the adaptation of these corners a conveyor can be adapted to almost any floor space or processing requirement, the firm states. Adjustments of corners can be made on the job.

The corners are used in conjunction with the company's continuous conveyor-A series which consists of link chain moving in steel tubes. Standardization of drives offers three sizes. Drive units are available with single speed or three to one infinite variable speed adjustment.

Systems up to approximately 350 ft and loads up to 30 lbs per ft are practical with one drive, the firm says. Conveyor hooks may be spaced as close as 6 in. centers. Top and bottom vertical turns and horizontal turns, track clamps and chains are available.

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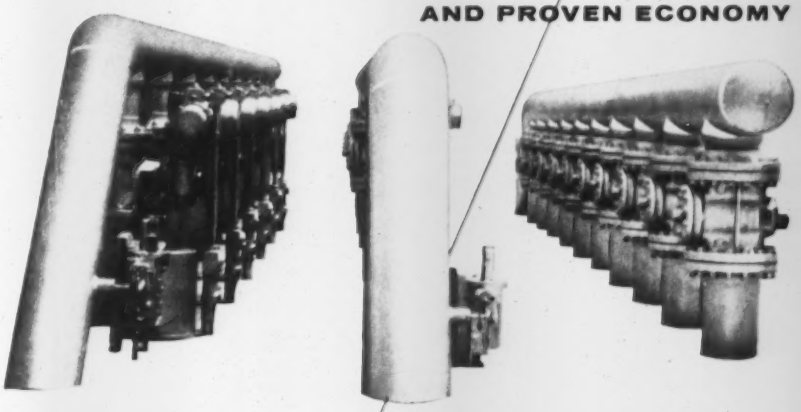

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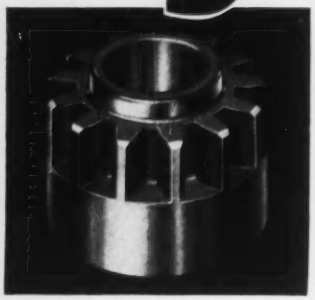

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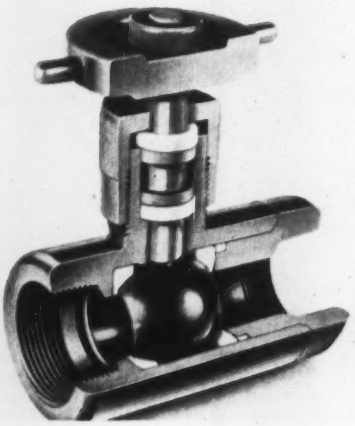


PVC Ball Valves

Jamesbury Corp. Worcester, Mass. introduces an all PVC valve in its "Double-Seal" ball valve design.

The new valve, according to the company, combines an outstanding design principle with a new material for handling corrosive and other difficult fluids. Sturdy construction permits use in many plastic or metal piping systems for either vacuum or pressure service, the firm states.

Full flow, quarterturn shut-off, with thousands of leaktight cycles and no maintenance are outstanding features claimed by the company. Valve seats are said to be easily replaceable. Rating is 150 psi at ambient temperatures and 50 psi at 130 F.

Sizes $\frac{1}{2}$ to 2 in. in screwed ends are available from distributors stocks. Flanged and weld ends will follow, the firm says.

Three and 4-in. sizes will be available shortly in flange and weld ends.

2-Pen-2-Zone Recorder

A new two-pen-two-zone recording instrument, for comparative measurement, is now included in the model 6700 line of recording-controlling instruments manufactured by Weston Electrical Instrument Corp., Newark 12, N. J., a subsidiary of Daystrom, Inc.

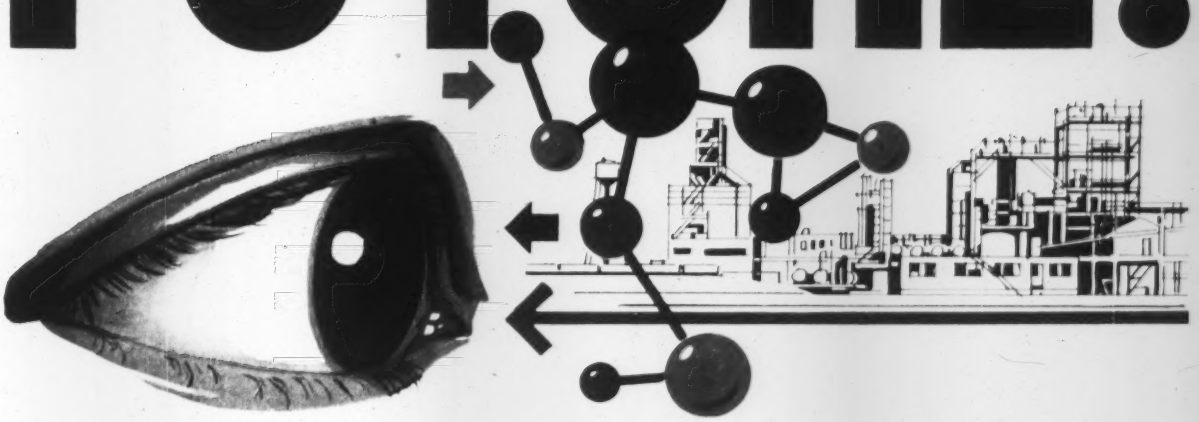
The Model 6791 Type 1 recorder is housed in a case measuring $17\frac{3}{4}$ in. wide to fit standard relay racks. It employs two electronic amplifiers of special plug-in type and two separate measuring circuits with replaceable range standards for quick range change on either one or both zones as desired.

Alarm switches are available for each zone. Slidewires are interchangeable, and totally enclosed. Chart speeds, available from 1 in. per hour to 1 in. per minute.

The unit is available with semi-automatic or fully automatic standardization on potentiometer, and is supplied in a dust and fume resistant case for universal mounting.

Continued on Page 48

FUTURE!



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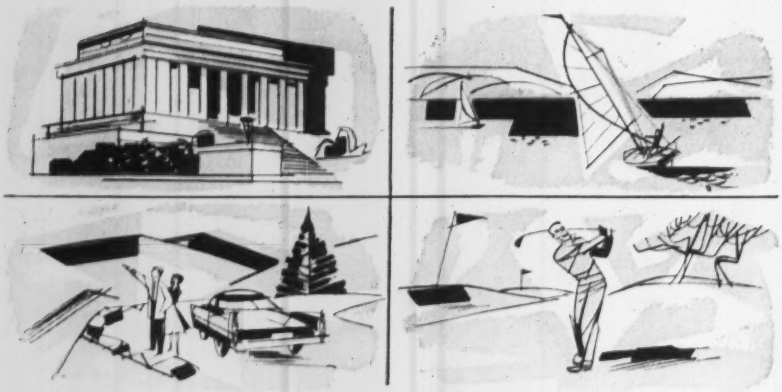

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KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Directional Valve

A new directional valve said to afford instant switch-over from automatic to manual control of diaphragm-operated valves, cylinders and similar devices, is announced by Valvair Corp., 454 Morgan Ave., Akron, Ohio.

The valve, installed as a tee in the inlet lines, permits manual take-over from automatic control, or control from two different sources, whenever desired, the company states. It also can be used to prevent intermixing of supply when two gases or liquids are being delivered alternately to a tank or container. Completely automatic in operation, the directional valve can be substituted for a dual top valve, the manufacturer says.

The valve consists of a captive Hycar ball which shuttles between two seats in the Navy M bronze valve body. When pressure is applied to one port, the ball shifts to, and seals, the opposite port.

Suitable for use with air, oil, water or media compatible with Hycar and bronze, the directional valve is available with $^1/_4$ and $^3/_8$ NPT ports. Net open area between seat and ball is equal to transverse area of $^3/_8$ standard pipe.

Roller Chain Sprockets

Morse Chain Co., Ithaca, N. Y., is now manufacturing a stock line of double strand roller chain sprockets for American Standard chain in pitches $^1/_2$, $^6/_8$, $^3/_4$ and 1 in., using the taper lock hub and bushing principles.

According to the company, using taper lock on these greater capacity drives provides the equivalent of a desirable interference fit on all shafts regardless if they are undersized by machining, special finishes or standard mill tolerances.

Snap-Acting Thermostat

Metal and Controls Corp., Spencer Thermostat Div., Attleboro, Mass., announces the Klixon C6786 Thermostat, a snap-acting disc type temperature control designed for aircraft controls, electronic circuits and components, servo mechanisms, gyroscopes, aerial cameras, guided missiles, gun mounts, or where high shock and vibration resistance is required.

The snap-acting disc thermal element and fine silver electrical contacts are enclosed with a stainless steel cup for full protection, the firm states. The base assembly is available in phenolic or silicone construction. Accurate operating temperatures range from −20 to 400 F. Temperature settings are factory pre-set, either standard range or special, as required by the application.

According to the company, miniature size makes the C6786 particularly suitable where space and weight accommodations are limited. Terminals are solder type. Performance characteristics include electrical ratings of 2 amperes, resistive, 115 VAC or 5 amperes, resistive, 30 VAC/VDC. Weight is 2.5 grams.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

High Temperature Oil

Keystone Lubricating Co., 3100 N. 21st St., Philadelphia, Pa., announces a specialized lubricant, No. 49 Light, that resists oxidation, sludging and breakdown.

While the oil was developed primarily for air compressor use, the company says its low carbon content and anti-gumming features make it a superior lubricant for such applications as ring bearings in electric motors, multiplate friction clutches, plastic molding heat transfer systems, drying oven conveyor chains, and textile tenter frames.

Gear Classifier

An automatic, probe-type, monitoring system for checking the root diameters of external splines or keyways on drum type parts has been added to the 3-way gear classifier line developed and built by Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.

The new unit uses a gaging action based on "point contact" of individual probes. These pre-set probes, by means of a controlled indexing, will check any or all root diameters of a part on a 100 per cent basis, the company states.

Oversize, undersize, and correct-size splines or keyways produced on hobbers, shapers, shavers, or Shear-Speed machines are gaged automatically using the root diameter as a reference base. According to the company, a two-point contact system—a lower stationary probe and an upper "floating" probe—measures 100 per cent of production from a single machine or a bank of machines. Both a visual and electrical check of production accuracy is provided within the specified tolerances of the spline root diameter.

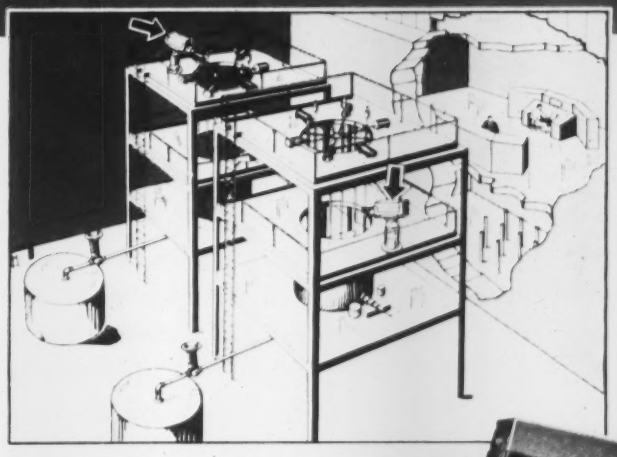
In operation, parts enter the classifier from the right side and move down an inclined ramp to a stop position, then are indexed as necessary and measured in the probe-sizing operation. Parts with root diameters within specified tolerances continue through the classifier to the next operation. Any oversize or undersize parts are automatically shunted aside and collected separately for salvage or scrap.

A cam and lever mechanism controls and times the probe movement as well as the escapement action that feeds parts to the probing station at a pre-determined rate. It also locates the part positively in relation to the upper and lower probes. A low speed, fractional-hp gearmotor drives the mechanism at a pre-determined speed fixed by the production rate, and cam-controlled linkage provides the desired inspection indexing. Variable limit switches actuate the shunting function.

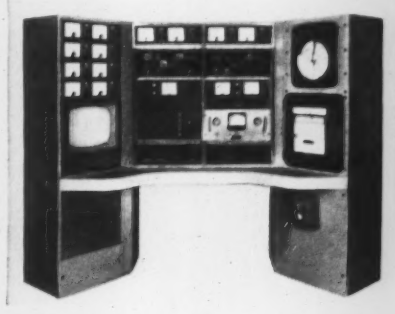
All operating parts are lubricated from a single central source. Adjustable features of the gaging and feeding functions allow the equipment to accommodate variations in part size at different rates of production, the firm states.

Diamond "UtiliVue" (WIRED TELEVISION)

used in NUCLEAR REACTOR STUDIES at Battelle Memorial Institute



Arrows indicate remotely controlled "UtiliVue" Cameras that SEE experimental nuclear reactor cores.



"UtiliVue" Monitor is built into control console in separate control room where experimental nuclear reactor cores can be WATCHED in perfect safety.

"UtiliVue" pedestal enables camera to be rotated 320° and tilted 90° by remote control from console. Zoom lens (also controlled from console) brings objects into focus at widely varying distances from camera.

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KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Quick Disconnect

A new high pressure quick disconnect is announced by Hydromatics, Inc., Cedar Grove, N. J.

It is described by the company as being the only unit available that can be used to disconnect safely and quickly a pressurized line, with pressures up to 3000 psi. With the handle in the upright position, an integral floating ball-seat valve is fully open.

To disconnect the line, the handle is rotated 90 deg down. During this movement, the valve closes and simultaneously, the pressure downstream from the valve seal is automatically bled out to allow the line to be separated without any danger, the firm explains.

The fitting at the downstream end cannot be removed while the valve is in the open position. The valve cannot be put into the open position with the downstream fitting disengaged.

Flexible Coupling

A radially removable flexible coupling which provides a simple means of disconnecting two units without axial movement of the shafts has been developed by the Lovejoy Flexible Coupling Co., 4886 W. Lake St., Chicago 44, Ill.

Designated Type RRL, the coupling is said to simplify maintenance and to be ideal for applications where driven equipment such as a pump must be disconnected while the driving unit continues to operate. All that is necessary in such cases is to disassemble the coupling itself.

Horsepower ratings range from 7.5 to 40 at 1800 rpm. Maximum bores range from $1^3/_8$ to $2^1/_4$ in. with maximum OD's from $2^9/_{16}$ to 5 in. Maximum overall length runs from $6^1/_8$ to $7^8/_8$ in.

Stepping Synchro

Development of a precision stepping synchro has been announced by G. M. Giannini & Co., Inc., 918 E. Green St., Pasadena 1, Calif.

Utilizing an electro-mechanical positioner to drive the rotor of a differential synchro in fixed increments of one degree, these instruments produce an a-c output that is synchronous with rotor position, the company states. Rotation of the mechanism is unlimited in both directions, and is operated by an electrical input pulse at any speed up to 60 deg. per sec.

Model 89161A-1 stepping synchros have integrated into their design the firm's Rotostepper. The shaft output of the Rotostepper is adapted to position accurately the rotor of the precision differential synchro.

According to the company, the stepping synchro will fit applications such as found in complex directional or guidance systems where the need exists for servo actuation in precise increments of rotation.

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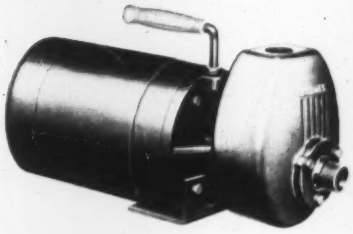

Close Coupled Pump

A new electrically driven close coupled pump being introduced by Barnes Mfg. Co., Mansfield, Ohio, as an addition to its self-priming centrifugal pump line. It was developed to augment the firm's established series of lightweight pumps designed for portable use or permanent pit installation.

The new pump, designated as close-coupled Model IMAE, is direct-connected to a 1/3 hp motor, 115 volt, 60 cycle, split-phase type delivering 3450 rpm. Pump discharges 1440 gph at 24-ft head. Officials of the company claim its extra power and high performance combine to produce either exceptionally large capacity or extra pressure if demanded. A balanced angle grip on top is designed to make the pump easy to carry, ideal for many emergency purposes and convenient standby use.

Feed-Water Regulator

A balanced flow type P feed-water regulator for high-duty steam generators, is announced by Copes-Vulcan Div., Blaw-Knox Co., Erie, Pa. The unit is designed to match feed-water input to steam output, regardless of load conditions.

According to the company, the regulator also holds drum level within close limits, despite changes in load or feed-water pressure. Control is modulated by three influences—drum-water level, feed-water flow and steam flow.

The two flow influences are obtained from primary elements of flowmeters. Each acts on a force-balance transmitter which sends an air impulse to a balancing (combining) relay. The transmitters can be mounted without regard to each other because they are not mechanically linked in any way. Drum-level impulse to the balancing relay is sent out by a pressure-compensated pilot operated by an inclined special-alloy thermostatic tube.

A simple slider adjustment on each transmitter permits modifying the output range to give a rising, lowering or practically constant drum water-level characteristic. The balancing relay permits either bias adjustment or 1 to 1 combining of the three control influence.

The system can be equipped with either diaphragm or piston operated control valves having rectangular, characteristic-V, sleeve or bevel-seated ports to match plant operating conditions. The company says almost

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any desired opening or closing force can be provided. Ports have flow areas exactly suited for specified flow and pressure conditions.

The auto-manual control station permits remote manual control of the feed valve. Having no "seal" position, transfer from manual to automatic and vice versa is said to be fast and bumpless.

2-Plane Accelerometer

Development of a small, light weight, potentiometer-type accelerometer which measures lateral accelerations in two mutually perpendicular planes has been announced by Genisco, Inc., 2233 Federal Ave., Los Angeles 64, Calif.

The new instrument, designated as model GDM, is said to be suited for aircraft and missile instrumentation requirements. The instrument will operate satisfactorily at temperatures between −10 F and +180 F. Rugged construction enables the unit to withstand mechanical and thermal shocks encountered in supersonic flight, the firm states.

The design incorporates two linear potentiometers internally mounted at right angles. Balanced range units are available in ranges from ±2 Gs and ± 30 Gs inclusive. Unbalanced range instruments can also be supplied, the company says.

Damping of the GDM is accomplished by the use of a silicone oil. Frequency response is characterized by a very close approximation to a second-order first-degree system. Change in damping with change in temperature is minimized by internal mechanical compensation.

The GDM weighs approximately 14 ounces, and measures $1^1/_8 \times 1^1/_8 \times 5^7/_8$ in. overall, including mounting flanges. It is encapsulated within a hermetically sealed case to provide complete isolation from external environmental contaminants. Either a miniature Cannon receptacle or hermetically-sealed glass header can be supplied.

Fluidization Units

Custom-made fluidization units to meet individual customer requirements have been announced by the American Agile Corp., Box 168, Bedford, Ohio.

According to the company, the new units provide the largest facilities yet available for the fluidization (dip coating) of irregularly-shaped targets with polyethylene, nylon and fluorcarbons.

Custom-made fluidizers are available in square, cylindrical and rectangular shapes, and in sizes from 15 in. in diameter, and 6 ft deep in the powder bed, to those measuring $4 \times 4 \times 4$ ft and 40 in. deep in the powder bed.

The side walls, in one piece are detachable by releasing the latch clips at the base of the fluidizer to allow access to the special design porous filter plates on which the finely divided powder resins rest. Air volume introduced through the air inlet, makes the powders fluid for coating. The cover is used to keep out foreign particles when the unit is not in use.

Continued on Page 54

1956 MANUAL OF CONSULTING PRACTICE FOR MECHANICAL ENGINEERS

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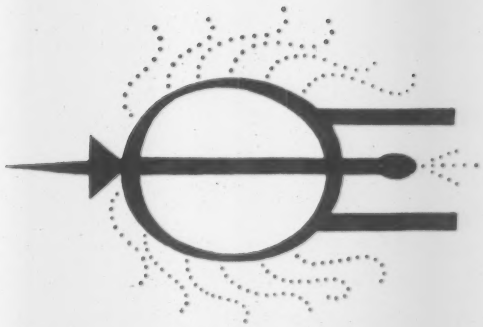

صفة بيضة تخرج وتخرق

er-Rammah's self-moving egg

Join two flat pans; fill with an incendiary mixture; add a tail; propel by two large rockets. In A.D. 1280, Arabia's Hassan er-Rammah, gazing centuries ahead, proposed this ovoid in his "The Book of Fighting on Horseback and with War Engines."

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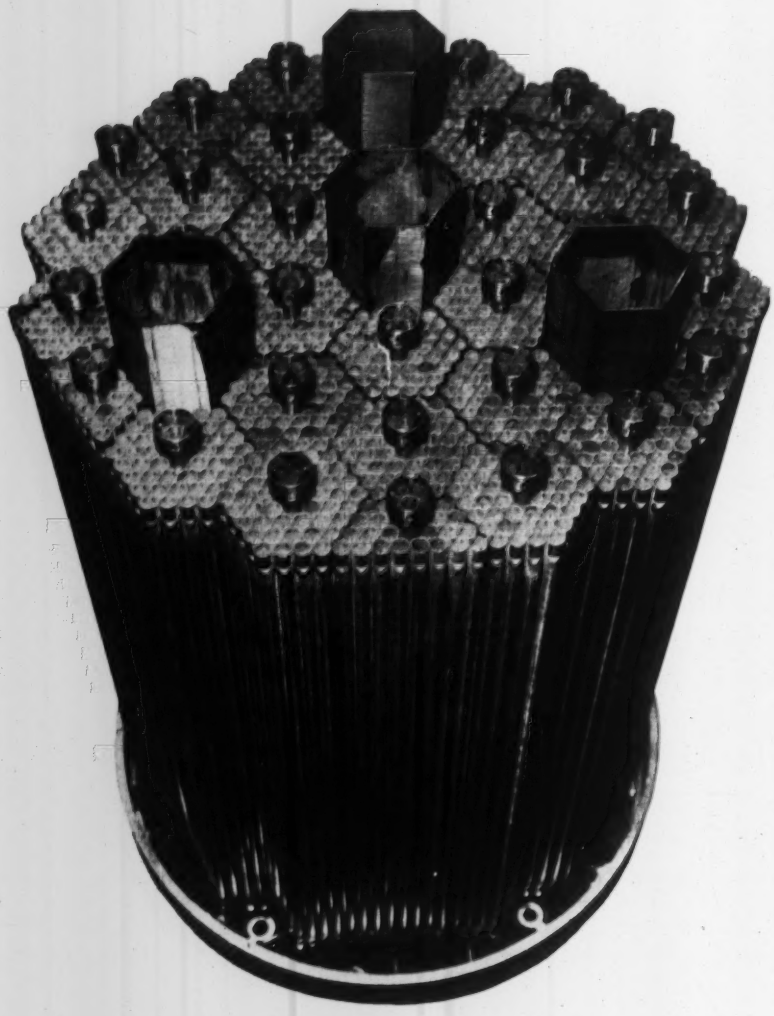

calliope for the nuclear bandwagon

Big Music from this 2′ x 2′ Martin fuel bundle, to the tune of 2,000 kilowatts for 18 months in a power system designed for transport by air... Packaged power, now under development at Martin, offers immense futures in the big parade of progress to undeveloped frontiers... Also Martin nuclear activities now rapidly expanding as a result of a major development contract in the field of aircraft nuclear propulsion... There are many excellent opportunities for engineers, with or without previous nuclear experience. Contact J. J. Holley, Dept. ME-2, The Martin Company, Baltimore 3, Maryland.

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Deflection Hangers

A line of steel spring Vibro-Hangers, for suspending disturbance-generating equipment and piping systems, said to provide maximum freedom from vibration transmission has been developed by The Korfund Co., Inc., 48-35N 32nd Place, Long Island City 1, N. Y.

The hangers utilize a helical steel spring as the high-deflection, high-efficiency vibration isolating medium. According to the company, the springs, made from top quality oil-tempered, carbon and alloy steels, will withstand high temperatures without permanent set, and low temperatures without losing their resilience.

The isolation units provide the greatest deflections and load capacities now commercially available, the company claims, and therefore constitute the optimum in eliminating transmission of vibration and noise where very low frequency disturbances are present, where extremes of temperature are encountered, or where the equipment is installed in critical locations. For less exacting requirements, rubber-in-shear isolation units are supplied.

The spring isolation units are supplied in a box-type housing as the Type VB, in a U-bracket housing as the Type VH, or without any housing as the Type VU. Effective load range from 50 to 3800 lb.

All-Electric Actuator

An all-electric actuator is a recent development of Conoflow Corp., 2100 Arch St., Philadelphia 3, Pa.

The series D actuator is a proportional positioning device for use in conjunction with modern electronic control systems. An unprecedented feature, according to the company, is that it requires no intermediate pneumatic or hydraulic operating fluids. The unit is said to combine the desirable features of an all-electric system with the mechanical simplicity and ruggedness of commercial pneumatic actuators.

The firm says the new model is suitable for immediate application on valves and other processing equipment, including single-seated and double-ported control valves, butterfly valves, proportioning pumps, mechanical and electrical speed controllers. The actuator is also said to be applicable for many complete all-electric systems where other modes of control have not proved practical. These include, the company says, automatic control involving transmission of signals over long distances, such as encountered in tank farms and pipe line services; and use in toxic atmospheres, or in areas where extremely low ambient temperatures are present.

The actuator has a stroke length of 1/4 to 2 in. with a stem speed of 4 in. per minute at the maximum rated output of 500 lb of thrust. Complete assembly of motor and yoke stands 25 in. high and weighs less than 35 lb. It can be mounted in any position and is not affected by normal vibration.

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NEW EQUIPMENT
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Control-Panel Fabrication

Time and effort required for installation of additional instruments on control panels is said to have been greatly reduced through introduction of a new panel board material by Panellit, Inc., 7401 N. Hamlin Ave., Skokie Ill.

The new panel material is $\frac{1}{16}$ in. sheet formica bonded to either side of $\frac{1}{4}$ in. aluminum plate. This formica-aluminum lamination is now offered in addition to painted $\frac{1}{4}$ in. steel plate for coordinated control panels fabricated by the manufacturer. It is available for all control room panel applications, including conventional large case, conventional large case graphic, and miniature graphic panels.

The company says ease of reworking this new material permits reduction of the time, effort and cost of panel revisions in the field. At the same time, the smooth, durable formica facing offers enhanced panel appearance and high resistance to scratching and denting. An additional major advantage results from a sharp reduction of panel material weight, reducing shipping and handling charges.

The firm says the use of formica on aluminum material for control panels has proved highly feasible because of near-equality in the components' coefficient of expansion. This is a factor that formerly thwarted efforts to bond formica to steel successfully for similar applications.

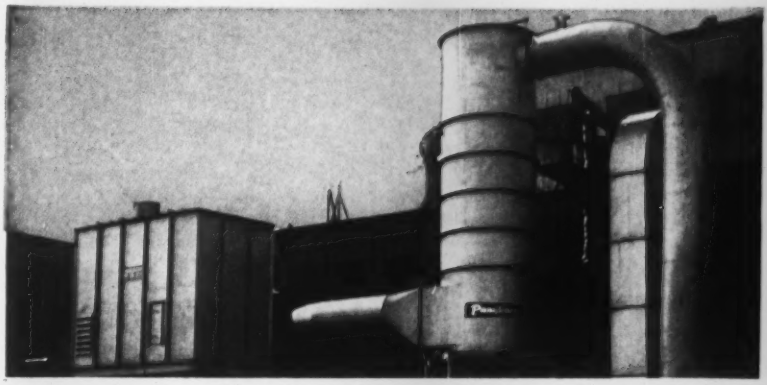
Arc Furnace Controls

A regulator for electrode control of large electric arc furnaces has been developed by Westinghouse Electric Corp., Box 2278, Pittsburgh 30, Pa. The unit is said to be capable of driving the electrodes at speeds and responses up to the limit that the drive motor can stand. The regulator's high performance is a result of a new application of magnetic amplifiers, the company explains.

Commutating ability of the motor is the ceiling that limits the electrode speed and response that can be furnished by the control. To make sure that the drive motor does not unduly limit the new magnetic amplifier control, low-inertia steel mill motors, specifically designed to commutate heavy armature currents, are used.

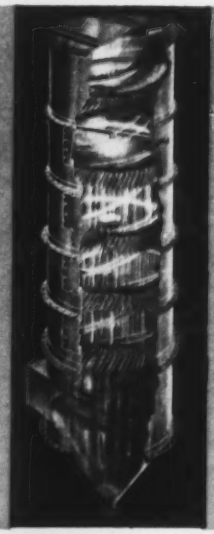
The regulator for each electrode uses a reversing magnetic amplifier to control a motor-generator set. Signals of arc voltage and arc current are compared by the regulator. Magnitude and direction of the output depends on which of the signals is the stronger, and on the ratio of the signal strengths. The firm points out that generally the voltage provides the "lower" signal, current provides the "raise" signal. A motor-generator set in turn powers the electrode motor, following the directions given by the regulator. Auxiliary equipment limits the electrode speed, motor armature current, maximum arc current, and other factors.

NOW...for efficient wet dust control



FARRELL-CHEEK STEEL CO., Sandusky, Ohio, uses a Pangborn Cloth Screen Collector for dry dust and a new Pangborn Centrifugal Wet Collector for hot and moist dust from shakeout and burning stations. According to Farrell-Cheek, "We are well-pleased with the Pangborn Wet Collector. It does its job efficiently, economically, and we have encountered no maintenance difficulties whatever."

Pangborn Centrifugal Wet Collector



For effective control of hot, moist, inflammable, abrasive, corrosive and obnoxious dust

Effective interaction of air and water explains the efficient performance of this new Centrifugal Wet Dust Collector by Pangborn. Dust-laden air enters the bottom of the collector tangentially and heavy dust particles are immediately precipitated by centrifugal action. Patented vanes cause the air to ascend on a tortuous centrifugal path, exposing it to thorough cleansing by descending water, after which it discharges through the top. Unique Pangborn counter-current design results in greater efficiency of operation, reduced space for rated capacity, lower operation cost through reuse of water and capacity geared to individual needs.

Pangborn CONTROLS DUST

If *your* dust problem involves the control of dust difficult to handle with a dry collector, write for details on the new Pangborn Centrifugal Wet Collector! Send for Bulletin 919 to PANGBORN CORP., 2200 Pangborn Blvd., Hagerstown, Md.
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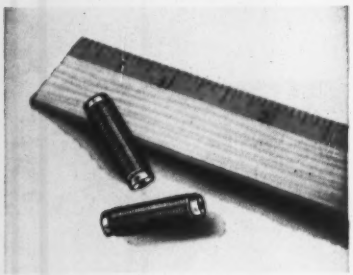
Production News from Bridgeport Thermostat

FROM THIS ALL-NEW PLANT— MORE AND BETTER BELLOWS

On its new 15-acre site at Milford, Conn., Bridgeport Thermostat now has 180,000 square feet of automated production facilities to assure quick delivery of all the bellows or bellows assemblies you need . . . at the lowest possible cost. A temperature and humidity controlled room for charging bellows assemblies is only one of the many ways in which this ultra-modern plant promises you bellows assemblies of consistently high quality.

¼" DIAMETER BELLOWS

Progress at Bridgeport is typified by this tiny bellows for miniaturization. Available in seamless design with a wide range of characteristics in brass, phosphor bronze, beryllium copper and monel. Larger sizes available.



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KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Phosphating Compound

Development of CrysCoat No. 47, designed to impart an iron phosphate coating of 80 to 120 milligrams in metal spray washing machines, has been announced by Oakite Products, Inc., 142A, Rector St., New York 6, N. Y.

The new compound cleans and phosphates in a simple three-stage operation. It removes light oils, grease, spinning compounds and shop soils and converts the surface of steel and iron into a thin, dense coating that resists corrosion and gives lasting paint adhesion, the company states. The coating, under standard finishes, has withstood more than 600 hours of salt spray testing.

The material is used at 1½ to 2½ ounces per gallon of water in the first stage of the washing machine. It is followed by a hot water rinse, then by hot chromic acid or the firm's rinse.

Water, Oil Seal

A self-contained, compact seal for use in jet water pumps, oil pumps, reduction units or appliances such as washing machines, has been introduced by Garlock Packing Co., 400 Main St., Elmira, N. Y.

The firm says the seal can be used on any rotating shaft to seal any liquids that will not attack the Buna-N flexible parts or the brass metal parts. The seal has been designated the BA12A-10.

The face of the seal, capable of withstanding high face loading and heat, is manufactured from filled true carbon to prevent porosity. Heretofore, the company states, faces on this type of seal have been made of molded plastic and the resultant flash marks in some instances has led to seal failure. Also the fired carbon withstands greater temperatures than the molded plastic component, the firm says.

A roll designed bellows has been incorporated into the new seal to allow greater travel than the old type traditional V-seal bellows. The brass metal shell incorporates a rigid two piece design in which the shell is rolled over an offset washer at the back. This imparts greater stability and strength to the new seal over the one piece stamped shell. The static O-ring is held firmly in a groove within the seal shell.

According to the company, this type ring seals higher pressure, gives a tighter fit and the seal can be mounted on a shaft from either direction. The seal has a metal back which rests against the stop, giving an exact mounting position.

The seal is recommended to operate against pressures up to 100 psi, and it is available for ⅝ and ¾ in. diameter shafts with general operating limitation of 212 F with shaft speeds up to 1000 ft per min. The stationary seat is of a high quality ceramic set in a Buna-N vibration ring.

Variations in dimensions of the ring and/or the stationary seat, or materials specifications of seal components are also available.

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NEW EQUIPMENT
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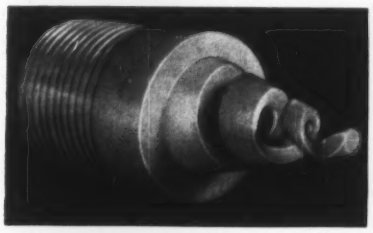
Washable Air Filter

A new air filter, announced by Air-Maze Corp., 25000 Miles Rd., Cleveland 28, Ohio, is said to combine the efficiency of a dry, oil-less, completely washable panel with a greatly extended filtering surface for longer service life.

A 20 × 20 × 2 in. panel, for instance, now has more than 20 square feet of filtering surface which is over 8 times the effective surface area of a conventional panel, the firm reports.

According to the company, a low-priced filter, Model P-70, is especially efficient in removing lint from recirculated air. It is particularly suitable, also, in applications where oil vapors cannot be tolerated, the manufacturer states.

The P-70 filter is not sensitive to changes in air velocity within normal range. Special screen grids on both sides of filter are designed to permit lint to be brushed off several times before washing is necessary. Filter offers washability in cold water, and may also be cleaned with a vacuum nozzle. The filter is made of aluminum screen and polystyrene-bonded fiber glass media in galvanized channel.



Full Cone Nozzles

Fourteen new spiral nozzles of Teflon have been added to the line of Bete Fog Nozzle, Inc., Greenfield, Mass.

The units make it possible to obtain full cone spray patterns, both wide angle 120 deg. and narrow angle 90 deg, in addition to the hollow cone models formerly manufactured by the company. A wider range of flow rates is also available.

The complete line, called the TF series, now includes nozzles with orifices from $^1/_8$ to $^1/_2$ in. diameter and with flow rates from 2 to 70 gpm.

The firm's exclusive spiral design is said to atomize the fluid without the necessity for vanes or internal parts. The manufacturer claims better atomization and non-clogging performance. Particles smaller than the orifice pass freely through the nozzle.

Each nozzle is made from a single piece of Teflon. The new nozzles are said to compare favorably in cost with nozzles of stainless steel or other corrosion resistant materials.

Acme

DOUBLE PITCH CHAINS become more popular with every application

Double pitch chains are becoming increasingly popular for applications where a precision roller chain is required and where cost is an important factor.

Acme's double pitch precision chain is available in standard steel and in a stainless steel line up to and including 1½" pitch for conveyors in the packaging, aircraft and many other industries. Stainless steel provides the greatest resistance to corrosion, which is an important factor in these industries.

If you use continuous process machinery in textile, agricultural, building, material handling, food processing, bottling or other fields, you should insist on Acme precision built double pitch roller chain. Acme stands up to your performance expectations.

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Ladle Stopper Head

A stopper head for huge ladles designed to reduce pouring accidents in steel mills and prevent spillage has been developed by Electro Refractories & Abrasives Corp., Buffalo, N. Y.

The improved stopper head reportedly can regulate the flow of molten steel as many as fifty times during a single heat without showing signs of cracking from heat shock or "spalling". The stopper is made from flake graphite, fused silica and fired refractory clay. For operating temperatures above the normal 2900 F, aluminum oxide is added to the mixture. The stopper is said to be so rugged, it can be taken out of a white hot furnace and placed on a cold floor without cracking.

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PUT Goshen Rubber TO WORK FOR YOU

GOSHEN RUBBER CO., INC. 3027 S. TENTH ST. GOSHEN, IND.

Potentiometer

Borg Equipment Div., George W. Borg Corp., Janesville, Wis., has announced production of its new 910 series single turn Micropot potentiometer.

The unit is described as a high precision instrument, linear in function, offering extreme accuracy, fine resolution, low torque, long life and consistent, reliable performance under adverse environmental conditions.

The resistance element and terminal leads are molded into a single unit for better operation under severe vibration and high temperature conditions. Units may be ganged, and each cup may be individually phased in the field. All models have ball-bearing mounted shafts.

The 910 series has a power rating of 5 watts at 40 C, and a resistance range of 50 to 10,000 ohms, (50,000 ohms, special), standard tolerance ±5 per cent. Standard linearity accuracy is ±0.5 per cent independent. Starting torque is 0.5 in-oz per section. Continuous mechanical rotation, 340 or less electrical rotation.

Net weight is 4 ounces per single unit, with 1 ounce added for each additional unit. Length of a single unit is $1^{3}/_{64}$ in., width $1^{7}/_{8}$ in. Shaft is $^{5}/_{8}$ in. long with special lengths available.

Compressed Air, Gas Trap

A new type of compressed air and gas trap has been developed by Hankison Corp., 951 Banksville Rd., Pittsburgh 16, Pa.

The trap discharges condensate from compressed air or gas lines by a combination of magnetic, pneumatic and automatic action.

According to the company, operation of the trap is simple. As the condensate in the trap rises, the float does not rise, but is held firmly in place by the magnet mounted on the pivot arm. When the force build-up of the condensate working on the float overcomes the magnetic attraction, the float snaps open the pilot valve.

Air enters the pilot valve, flows down the stem, and up under the piston, forcing the piston assembly upward. As the piston assembly moves upward it opens the main discharge valve. The condensate is forced into the main discharge valve by the system pressure, and out into the discharge outlet.

When sufficient condensate has been discharged, the float drops, and the magnetic attraction of the magnet to the float arm causes the snap closing of the pilot valve. When the pilot valve snaps shut, the air supply to the piston is cut off. The air in the piston chamber bleeds through a minute orifice; piston immediately returns to its original position, closing the main discharge valve.

The piston mechanism in the trap is completely sealed off from the condensate to prevent damage or clogging. Pressure range of the trap is from 10 to 200 psig.

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6000-lb Fork Truck

Designed for use where severe operating conditions are encountered in day-to-day handling, a new 6000-lb-capacity heavy-duty fork truck has been introduced by Elwell-Parker Electric Co., 4205 St. Clair Ave., Cleveland 3, Ohio.

As a stand-up model, the truck is said to provide maximum ease of mounting and dismounting. An unobstructed operator's compartment permits mounting from either side.

The new truck is claimed to have maximum visibility for the operator.

The firm says hydraulic lift and tilt provides the fastest such operations of any comparable truck now available; hydraulic wheel brakes are another exclusive feature; and hoist speeds are also stated to be the fastest yet available with a model of this type.

Specifications include travel speed of 5.5 mph without load, 5 mph with full load; Hoist speed, with full load, 20 fpm up, 40 fpm down; without load, 40 fpm up, 36 fpm down.

The truck features four-speed magnetic control with time delay between speeds; deadman control is included. The drive unit consists of a motor vertically mounted and directly connected through a free coasting worm gear first reduction, spur gear second reduction. Drive shafts are mounted on taper roller bearings and are splined to a four-pinion differential.

Wheels are connected to drive shafts through forged clutch plates which are doweled and bolted to the cast steel wheels and splined to the drive shaft.

Vernier Caliper

A caliper described as "the ultimate in vernier gage design" has been developed by L. S. Starrett Co., Athol, Mass.

Called the No. 123 Satin Chrome Master Vernier caliper, the new tool has 50-division vernier scales with widely spaced, graduations to simplify setting and reading without the use of a magnifying glass. According to the company, this feature permits having half the conventional number of graduations on the bar which further assists in fast, accurate reading.

The tool is designed with both vernier plates fitting flush with the main scale. The new open-face design permits placing both the inside and outside vernier scales on the same side of the tool. The caliper is held and read exactly the same for inside and outside measurements.

All reading surfaces of the gage are finished in satin chrome, a long-wearing multiplate finish to eliminate glare and facilitate reading under all lighting conditions. Other surfaces are hard chrome plated for resistance to rust and stains. The master bar and both vernier scales are machine divided to exact standards of accuracy.

Electroplating Chemical Line

Wagner Brothers, Inc., 400 Midland, Detroit 3, Mich., has entered the plating chemical processing field.

The following processes are compounded: Iso-Brite copper, white brass, cadmium and zinc, Iso-Lok chromate finishes, Wabrite nickel and Krome-on, a chromic-acid mist-inhibiting aid to plating throwing power introduced a year ago, the company claims.

Also introduced recently is the firm's line of Benchmark metal cleaners including general all purpose soak cleaners, electrolytic cleaners for zinc base die castings, brass and copper and an anodic high detergency cleaner for removing smut from steel; others include electrolytic and soak cleaners for buffed copper, ferrous metals, aluminum and alloys.

Introducing...
the Roof Ventilator
"Twins"
Bell-Ex Centrifugal Roof Ventilator
VP-Ex Propeller-type Roof Ventilator
...economical
space-saving roof units to
simplify your ventilating problems
When roof ventilators provide the answer to your ventilating needs, select one of the nyb "Twins" for maximum dependability . . . and economy, too! The Bell-Ex will exhaust against high resistances effectively from hoods and duct work; the VP-Ex is a sturdy, flexible unit that may be used where resistances do not exceed ¼ inch static pressure. The "Twins" are completely weatherproof and corrosion-resistant, easily accessible for maintenance . . . and of modern design to complement any exterior.
Write today for bulletins 848 and 566 for further details on the Bell-Ex and VP-Ex "Twins"
nyb
THE NEW YORK BLOWER COMPANY
SALES OFFICES: 3161 SOUTH SHIELDS AVE. • CHICAGO 16

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may be as near

as your **telephone**

The telephone rings. You pick it up and begin talking with a man you've never met. You ask a number of questions — important questions about career opportunities, pointed questions about salary range, work assignments and advancement possibilities.

When you put the receiver down, you may well be on your way to a more challenging, more promising, more secure future.

Assuming you have the necessary background, how do you arrange a call like that? Simply fill out the coupon below.

FLORIDA FACILITY — *Immediate openings also for designers who would eventually like to transfer to our Florida Facility. Initial training will be at our East Hartford, Connecticut, headquarters.*

Mr. E. M. Peterson, Office 35, Design Employment
Pratt & Whitney Aircraft, East Hartford, Conn.

I would like to learn more about your openings for product and component designers. My experience has been in the following fields:

☐ Nuclear Design ☐ Aerodynamics ☐ Bearings
☐ Compressors ☐ Hydraulics ☐ Piping
☐ Turbines ☐ Gears ☐ Controls
☐ Structures ☐ Valves ☐ Test Equipment
☐ Afterburners and Related Equipment ☐ Heat Exchangers and Combustion Problems ☐ Test Rigs

Total years Mechanical Design experience .....

You can reach me at ..... Most convenient (home telephone) hours for receiving calls are between ..... and .....

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HOME ADDRESS .....

CITY ..... STATE .....

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DIVISION OF UNITED AIRCRAFT CORPORATION

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Stereo Microscope

An American-made stereo microscope at low cost is announced by Edmund Scientific Co., Barrington 17, N. J.

The microscope provides up to 3 in. working distance and gives an erect, clear sharp image, correct as to right and left, the firm states. The viewer sees a wide, three dimensional field with excellent depth perception.

A standard pair of wide field 8X Kellner eyepieces gives 21 power and 34 power, and additional eyepieces are available for greater or lesser magnification. The prism erecting system is low reflection coated. The unit has helical rack and pinion focusing with large control knob for fine adjustment. Interpupillary distance is adjustable.

The stereo microscope is said to be highly practical and efficient for inspections, examinations, counting, checking, assembling, dissecting for speeding up and improving quality control.

Tubular Heater Seal

A new tubular heater seal, said to be suitable for economical application to both industrial equipment and domestic appliances, has been announced by the General Electric Company's Industrial Heating Dept., Schenectady 5, N. Y.

The sealing material is a special plastic resin used in conjunction with a ceramic bead. A shoulder on the bead controls the creepage distance from the terminal to the sheath, without adding to the dimensions of the heater, according to the firm.

The new seal, giving protection against moisture and fumes, is recommended for application where leakage current characteristics do not exceed 200 micro-amperes. It is available on all sizes of tubular heaters for temperatures up to 300 F.

Continued on Page 63

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If you would like further engineering information on any of the products advertised in this issue, circle the page numbers of these ads on one of the cards below . . . fill in your name and address and mail to us.
Your requests will be forwarded to the advertiser. The information will come directly to you.

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29 West 39th Street
New York 18, N.Y.

MECHANICAL ENGINEERING—FEBRUARY 1957 issue

IFC	15	31	44	63	74L	84	95–96	115	126	137	150	156BR
1	16	32	45	65L	74R	85	97	116	127	138	151	157
2	17–20	33	46	65R	75	86L	101	117	128	139	153L	158
3	21	34	49	66L	76L	86R	105	118	129	140	153R	181
4–5	22–23	35	51	66R	77	87L	106	119	130	141	154TL	183
6–7	24–25	36	55	68T	78L	87R	107	120	131	142	154BL	IBC
8–9	26	37	56	70T	79	88–89	109	121	132	143	155T	OBC
10–11	27	39	57	71T	81	90	110	122	133	145	155B	
12–13	28–29	41	58	72TL	82	91	111	123	134	147	156TL	
14	30	42	59	73R	83	93	113	125	135	149	156TR	

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MECHANICAL ENGINEERING—FEBRUARY 1957 Issue

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1	16	32	45	65L	74R	85	97	116	127	138	151	157
2	17–20	33	46	65R	75	86L	101	117	128	139	153L	158
3	21	34	49	66L	76L	86R	105	118	129	140	153R	181
4–5	22–23	35	51	66R	77	87L	106	119	130	141	154TL	183
6–7	24–25	36	55	68T	78L	87R	107	120	131	142	154BL	IBC
8–9	26	37	56	70T	79	88–89	109	121	132	143	155T	OBC
10–11	27	39	57	71T	81	90	110	122	133	145	155B	
12–13	28–29	41	58	72TL	82	91	111	123	134	147	156TL	
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FIRST CLASS
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MECHANICAL ENGINEERING
29 West 39th Street
New York 18, N.Y.

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Precision Force Gages

Hunter Spring Co., Lansdale, Pa., announces the development of a series of mechanical force gages capable of holding the maximum reading after the load has been removed.

Said to be similar to the company's standard Series D force gages, the four new units have maximum load capacities of 50, 100, 150 and 200 lb. The instruments are designed for making force measurements, both in tension and compression, especially in awkward positions where it is difficult to read the gage in the measuring position, where measurements cannot be held steady and for measuring such momentary loads as peaks and break-points.

A single control button selects the desired gage operation, either to hold the maximum reading or to follow all load fluctuations. If set to record maximum load, the dial pointer remains at that reading until released by a touch of the button. Since only one pointer is used there is no follower hand to be reset after each measurement. Thus, the company explains, if a maximum force has been recorded, the gage is simply released and reset for the next measurement by a flick of the control button.

Barrel Finishing Spheres

Norton Co., Worcester 6, Mass., has announced a new barrel finishing media, Tumblex S abrasive spheres. These spheres come in five different diameters and are made of the firm's Alundum aluminum oxide abrasive.

According to the company, the spheres have proved satisfactory for finishing tubing, coil springs, scissor handles, bearing retainers, pump bodies and other parts where conventional tumbling abrasive tends to wedge or will not reach.

Freight Car Bearing

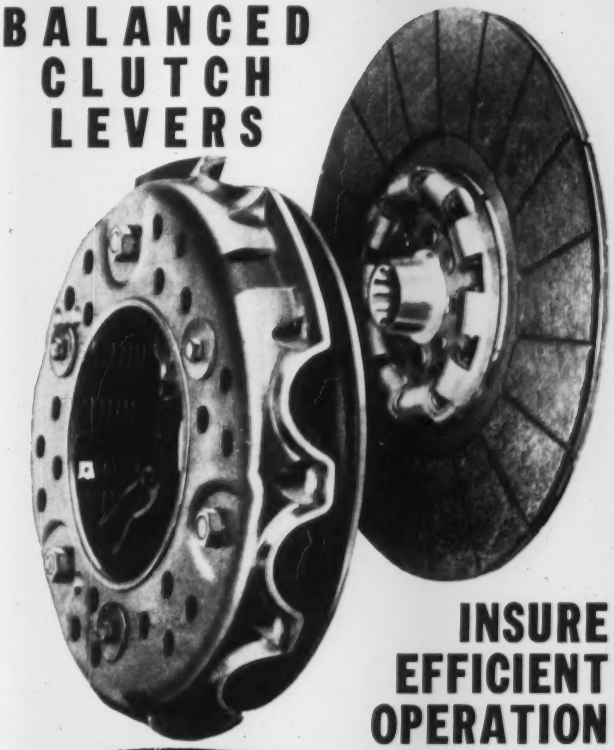
A removable type freight car journal bearing has been announced by SKF Industries, Inc., Philadelphia, Pa. The new roller bearing, called the general purpose freight car bearing, will mean reduced maintenance cost for the user by permitting fast inspection and quick repairs, without the need of expensive special equipment, the company claims.

For inspection purposes, the outer race assembly of the new bearing is easily dismounted by hand while the inner race and enclosure collar, which are fitted to the axle, remain in place.

Another feature of the new bearing is a special self-lubricating seal. Several holes have been strategically drilled between the lips of the seal. Besides providing an air vent, the design furnishes a means of disposing of excess lubricant and using this grease to lubricate the surface between the seal and the axle cap, the firm states.

ROCKFORD

BALANCED CLUTCH LEVERS



INSURE EFFICIENT OPERATION

Small Spring Loaded

Automotive Spring Loaded

Heavy Duty Spring Loaded

Oil or Dry Multiple Disc

Heavy Duty Over Center

Light Over Center

Power Take-Offs

Speed Reducers

The release levers in ROCKFORD clutches have been newly designed and are accurately balanced—so necessary in present day *high-speed, high-torque* engines. This is just one of several advantages ROCKFORD equipped motor vehicles feature in their late models.

SEND FOR THIS HANDY BULLETIN

Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

ROCKFORD Clutch Division BORG-WARNER

1307 Eighteenth Ave., Rockford, Ill., U.S.A.

Export Sales: Borg-Warner International — 36 So. Wabash, Chicago 3, Ill.

ENGINEERING B-W PRODUCTION

CLUTCHES

Can you qualify for one of these six specialized engineering positions?

1 **Experienced Instrument Engineer.** Design work on aircraft instruments, controls and displays. Electrical Engineering degree or equivalent essential. Human Factors engineering experience on displays desired.

2 **Experienced Human Factors Engineer.** Design work on aircraft control and displays. Industrial Psychology degree or equivalent essential. Specific experience on instruments desired.

3 **Experienced Aircraft Air Conditioning Engineer.** Work on weapons system advanced design aircraft. BSME or equivalent essential.

4 **Experienced Aircraft Engineer.** Work on environment control engineering or weapons system advanced design aircraft. BSME or equivalent essential.

5 **Experienced Aircraft Engineer.** Work on escape systems design on weapons system advanced design aircraft. BSME or BSAE degree or equivalent essential.

6 **Experienced Aircraft Engineer.** Cockpit arrangement and provision studies on weapons system advanced design aircraft. BSME or equivalent essential. Human Factors experience desirable.

CONTACT: Mr. Les Stevenson, Engineering Personnel, Dept.562-ME, North American Aviation, Inc., Los Angeles 45, California.

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NORTH AMERICAN AVIATION, INC.

NORTH AMERICAN HAS BUILT MORE AIRPLANES THAN ANY OTHER COMPANY IN THE WORLD

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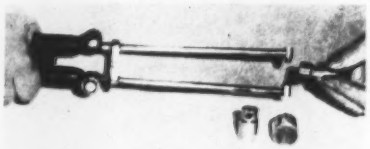
Hot Work Die Steel

Vanadium-Alloys Steel Co., Latrobe, Pa., announces it is marketing a new hot work die steel named Jet Forge.

The material is described as a high chromium steel which has given excellent performance records during a recent period of on-the-job testing in plants manufacturing jet engine blades and buckets. These are made from newly developed alloys which offer forging problems that obsolete the standard chromium type die steels formerly used for this purpose, the company states. The new hot work die steel has improved resistance to heat checking, the firm claims.

Although specifically originated for high temperature forging applications, it is expected by the company that the new tool steel will prove adaptable to applications calling for toughness, wear resistance, and the ability to maintain strength at elevated temperatures. It is available from stock as bars, billets, disks and forgings.



Gas-Oxy Hand Torch

A new development in gas-oxygen hand torches is announced by Bethlehem Apparatus Co., Inc., Hellertown, Pa. The company has introduced a torch with three interchangeable tips for divergent applications in the glass working and metalworking fields.

The tip can be changed simply by squeezing the handles. As the handles are squeezed, the tip drops out, and can be replaced by inserting the new tip between the prongs. The tip can be tilted freely to any angle.

Constructed on the principle of the Polymix flame, which the firm developed last spring, the new "InstoChange Hand Torch," as it is called, is claimed to have unprecedented heat volume and noiseless operation, due to a thorough mixture of gases and complete elimination of turbulence. This thorough gas mixture is obtained by the intimate grouping of the gas and oxygen outlets in a compact area.

Ninety-six orifices are clustered in an area of 1 in. o.d. in the large burner. The small burner has 12 orifices and the medium-sized burner has 48 orifices in burner head diameters of $^{3}/_{8}$ and $^{3}/_{4}$ in. respectively. Turbulence is said to be eliminated by the use of exceedingly small circular orifices in the head for both gas and oxygen, thus producing a true viscous flow. Oxygen is fed through more than 48 capillary tubes in the large burner. The small burner head has 6 tubes through which oxygen flows, and the medium

NATIONAL AIROIL

Oil Burners

OF THE STEAM AND MECHANICAL TYPES NOW COMBINED INTO

Dual Stage BURNERS

Now, at last, the inherent advantages of *both* systems of fuel oil atomization are *profitably* yours . . within the one, new NATIONAL AIROIL Dual Stage Burner.

45 years of combustion equipment design and manufacture are in back of the Dual Stage Oil Burner . . and, it has been thoroughly tested and proved in the field for firing: Petroleum Processing Heaters; Rotary Kilns; H.R.T., Scotch Marine and Water Tube Boilers; etc.

Available in three sizes, the NATIONAL AIROIL Dual Stage Burner fires all grades of fuel oil from No. 2 to No. 6, with a ready capacity of 80 to 300 g.p.h. Further, for a perfect flame pattern, we would recommend using with the Dual Stage Burner either the NATIONAL AIROIL Universal Register for forced draft or, the NATIONAL AIROIL Tandem Unit for natural or induced draft furnaces.

Get detailed descriptions, illustration, and specifications in NATIONAL AIROIL Bulletin 25.

OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes
STEAM ATOMIZING OIL BURNERS
SLUDGE BURNERS, Steam Atomizing
MOTOR-DRIVEN ROTARY OIL BURNER
MECHANICAL PRESSURE ATOMIZING OIL BURNERS
DUAL STAGE, combining Steam and Mechanical Atomization
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GAS BURNERS
COMBINATION GAS & OIL BURNERS
FUEL OIL PUMPING and HEATING UNITS
FURNACE RELIEF DOORS
AIR INTAKE DOORS
OBSERVATION PORTS
SPECIAL REFRACTORY SHAPES

Established 1912 — Incorporated 1917

NATIONAL AIROIL BURNER CO., INC.

1239 E. Sedgley Ave., Philadelphia 34, Pa.

Southwestern Div.: 2512 So. Blvd., Houston 6, Texas

KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

burner head has 24 capillary tubes. The gas and oxygen unite entirely outisde the burner head.

As a result of this principle there is an absence of "cold spots" in the flame, the firm states. Flashback is claimed to be impossible even when the gas or the oxygen valves are shut off abruptly. Combustion is complete and firechecks are said to be unnecessary.

The new torch burns gas at ordinary city pressures. It will burn manufactured or natural gas, as well as hydrogen, propane and other gases. With any of these gases, the three tips work glass tubings from the smallest up to 85 mm hard glass.

Air-Powered Hoists

Availability of two new air-powered hoists with maximum load limits ranging from 1100 to 2200 lb is announced by Atlas Copco Eastern, Inc., Paterson, N. J.

Company spokesmen say the new units will fill a general need for dragging, skidding and lifting in mines, quarries, industrial plants, and on construction sites. Designated the MHG-41 and MHK-61 hoists, the units offer operational control ranging from creep to rope speeds up to 160 fpm at full load. Both hoists operate at air pressures of 85 psi.

The 265-lb MHG-41 operates from a 1-in. air line and can lift up to 1100 lb. Equipped with 400 ft of $^5/_{16}$-in. wire rope, the MHG-41's rope drum is $7^1/_8$ in. wide and $6^7/_8$ in. in diam. Motor output is rated at approximately 6.2 hp.

The 530-lb MHK-61 which has a motor output of approximately 13.2 hp can handle 2200 lb loads. Operating from $1^1/_2$-in. air line, the MHK-61's rope drum is $9^7/_8$ in. wide and $9^1/_4$ in. in diam. It is equipped with 460 ft of $^5/_{16}$-in. wire rope.

Electronics Air Filters

Announcement of a new line of permanent air filters for use in electronics equipment of all types has been made by Farr Co., Box 45187, Airport Station, Los Angeles 45, Calif.

The new filters are specially designed to meet the need for increased cabinet ventilation in miniaturized electronic equipment, the company reports. Their sizes range from 2 × 2 × 2 in. to 2 × 2 × 8 in. A round type, 2 × 3 in. diameter, is also available.

The miniature units are a permanent metal type and have a herringbone crimped media design that permits the progressive loading of dirt through the entire filter without face loading which impedes air flow.

The media design is said to permit quick cleaning in ordinary water. All units meet Navy and Airforce specifications.

It is also announced that additional sizes and shapes of these miniature filters will become available as needed by the electronics industry.

LOW TEMP LUBRIPLATE

Best for Sub-Zero Lubrication

Highly recommended for general grease applications on all types of machines operating at very low temperatures. Remains plastic at temperatures as low as 70° F below Zero and has a Melting Point of 270° F. Possesses high film strength and is of a consistency that meets all requirements. Can be easily applied through grease guns or by other means of application. LOW TEMP LUBRIPLATE is waterproof and will protect automotive and other types of equipment against the unfavorable effect of salt or calcium chloride as used on highways during winter months.

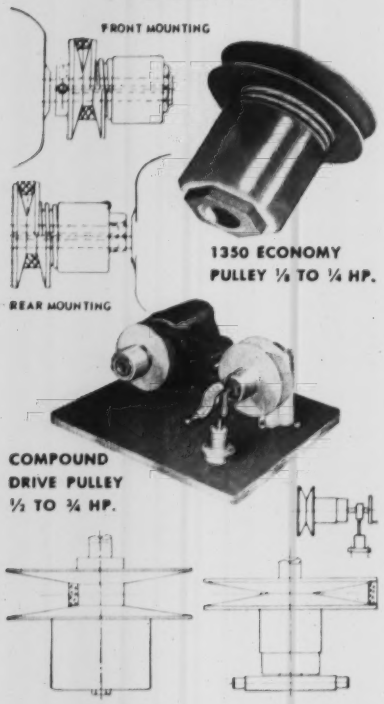
REGARDLESS OF THE SIZE AND TYPE OF YOUR MACHINERY, LUBRIPLATE LUBRICANTS WILL IMPROVE ITS OPERATION AND REDUCE MAINTENANCE

For nearest LUBRIPLATE distributor see Classified Telephone Directory. Write for free "LUBRIPLATE DATA BOOK". . . a valuable treatise on lubrication. LUBRIPLATE DIVISION, Fiske Brothers Refining Company, Newark 5, N. J. or Toledo 5, Ohio.

Lovejoy

Fractional Horsepower

VARIABLE SPEED PULLEYS



Economical—
low in initial cost . . . easily installed on old or new equipment.

Minimum Maintenance—
simple construction assures trouble-free operation . . . lifetime lubricated with oil-impregnated bronze bushings.

Constant Belt Alignment—
inner and outer pulley sheaves open equally to provide smooth, infinitely variable speed ratios to 8 to 1.

No Slippage—
Sure grip of belt sides delivers full traction under all load conditions...result is greater horsepower carry capacity.

Get the new 12-page Lovejoy catalog! Write today.

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4832 W. Lake St., Chicago 44, Ill.

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Graphitic Brushes

Ohio Carbon Co., Dept. 283, 12508 Berea Rd., Cleveland 11, Ohio, states that performance of its new D series of brush grades under adverse conditions, has now been fully proved.

The grades are described as characteristically electrographitic lamp black brushes of the highest quality manufactured primarily for modern d-c motors and generators. This series is distinguished by universally high contact drop, low friction, and good carrying capacity, the firm states.

The grades of this series are recommended by the company for modern a-c and d-c heavy duty traction, locomotive, mill, mine, crane, elevator and electric shovel motors, and for general service on almost all d-c generators and synchronous converters.

Torque Control Tools

Thor Power Tool Co., Aurora, Ill., announces a new line of power tools for the high speed mass production market—air and electric screwdrivers and nutsetters claimed to make possible precision torque control in the assembly of threaded fasteners.

A new clutch principle developed by the firm's engineers is said to put positive torque control into the hands of even inexperienced assemblers. The new line is identified as "Uni-Tork."

The torque adjustment is set on the outside of the new clutch attachment, and the clutch disengages instantly and completely when the pre-set torque is reached. The cycle is snap-action, with no ratcheting, slipping or buzzing of the clutch jaws, the firm states.

The torque setting is claimed to hold indefinitely, assuring uniform tightness and quality in the assembled product, permit highest speed operation from the original set-up through all types of assembly, and prolong the service life of clutch and tool parts. The units have a range of adjustments from 10 to 100 in-lb torque.

Centrifugal Blower

Industrial Plastic Fabricators, Inc., Endicott St., Norwood, Mass., announces the availability of a new, 40-in. diameter corrosion resistant PVC centrifugal blower, Model No. CB-40M, with a capacity of 15,000 cfm.

The new model is said to be especially applicable to installations used to expel corrosive air and fumes.

The impeller wheels are designed with back curve, non-overloading characteristics said to maintain high efficiency for the conveyance of air and gases. The company says vibration is essentially eliminated and the impellers are not subject to unbalance. Blowers are equipped with a PVC shaft seal, and inlet and outlet flanges, gaskets, and drain plug are standard PVC parts of the blowers.

DO IT YOURSELF and SAVE SAVE SAVE

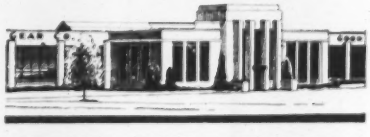
Paul W. Thurnauer Jr.
VICE-PRESIDENT, THE CINCINNATI GEAR CO.

News Item: *Statistics show that hospital emergency wards do a rushing business on weekends — and not just after Saturday midnite, either, but all weekend long — patching split heads, wrenched backs, mashed thumbs, broken arms and chopped feet. All this "business" results from that modern phenomena, "do it yourself."*

Any fool knows that "do it yourself" is the way to "Save - Save - Save," as the TV commercials say. But some of the *smarter* people have discovered that "do it yourself" isn't necessarily the bargain-counter proposition it's been made out to be — that the fun you get out of it (if any) generally costs *money* in the long run. These people are relearning a truth established years ago that the Division of Labor, or specialization, results in greater efficiency. This holds just as true in the production of industrial goods such as gears: the actual cost, hidden as well as apparent, of gears produced in a back shop or part-time department is bound to be greater than the ultimate cost of gears produced by an efficient, highly-specialized gear manufacturer like Cincinnati Gear. And combine the economic advantages that result from our efficient production and consistent top quality with the *ease-of-mind* that results from our traditionally top-notch *service*, and you'll understand why so many firms (firms who recognize "do it yourself" for what it is) depend on us year after year for all their custom gear requirements.

THE CINCINNATI GEAR CO.
CINCINNATI 27, OHIO
Fifty Years of "Gears—Good Gears Only"

CINTI ®



ENGINEERS

Mechanical, Electromechanical

The Johns Hopkins University
Applied Physics Laboratory

ANNOUNCES

. . . important openings on our guided missile research and development staff for men who wish to identify themselves with an organization whose prime purpose is scientific advancement.

Because the Applied Physics Laboratory (APL) exists to make rapid strides in science and technology, staff members require and receive freedom to inquire, to experiment, to pursue tangential paths of thought. Such freedoms are responsible for findings that frequently touch off a chain reaction of creativity throughout the organization. As a staff member of APL you will be encouraged to determine your own goals and to set your own working schedule. You will also associate with leaders in many fields, all bent on solving problems of exceptional scope and complexity.

Equidistant between Baltimore, Md., and Washington, D. C., our new laboratory allows staff members to enjoy suburban or urban living and the rich cultural, educational and research facilities offered by both cities.

Openings Exist in
These Fields:

DESIGN: *Airframes and structures; hydraulic and power supply systems; servomechanisms; launching and handling equipment; ramjet engines; warheads.*

ANALYSIS: *Stress; weights and loads; heat transfer; dynamics; warheads.*

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KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Pressure Transmitters

A significant reduction in response time is claimed for a new line of pressure Synchrotel transmitters designed by Kollsman Instrument Corp., 80-08 45th Ave., Elmhurst 73, N. Y.

The new instruments, used in high speed aircraft and guided missiles for transducing pressure values as electrical signals, are lighter, more compact, and have far less internal static volume than previous models, the firm states.

According to the company, the pressure transmitters are used with air and navigation data computers as well as with flight and engine control units, wherever accurate measurement of differential or absolute pressure functions is mandatory, and where space and weight are critical factors. As a result of the instrument's new design, its applications to problems of ultra sonic speeds and high altitudes have been substantially increased, the firm says.

Castings used on previous models of the pressure transmitters have been replaced by new lightweight sheetmetal cases. Overall weight is down to approximately 1 lb, a reduction of one-third as compared with previous models. The greatly diminished internal static volume results in significantly better response time. This higher dynamic accuracy is said to be further aided by more precise calibration and better temperature compensation.

Electromagnetic Switch

Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago 12, Ill., announces the Powerloid, a power-type electromagnetic switch actuated by a solenoid plunger.

It is said to combine the characteristics of both a relay and a solenoid. Designed primarily for heavy duty motor and heater loads, unit has been tested for 230 volt a-c motor loads up to 3 hp and for heater units up to 8400 watts. The unit is totally enclosed.

According to the company, applications include washing machines, high-speed dryers, air conditioning and refrigeration equipment, built in and electronic ovens, magneto starters, battery chargers and heater controls.

Available contact combinations include single pole, single throw, dual make; single pole, single throw, dual break; or with single pole, double throw, dual make and dual break; also with single pole, single throw, dual make, or single pole, single throw, dual break, utilizing an auxiliary switch on the outside of the switch housing.

Contact terminals are 8-32 × 1/4 in. screw type; spade terminals are .032 × .250 in. tabs designed for AMP female receptacles. Assigned contact ratings: 3 hp U/L motor load at 230 volts, 60 cycles, 6000 watt resistive load; 500 watt tungsten lamp load. Coils are standard voltages up to 230 volts a-c, 60 cycles and up to 110 volts d-c.

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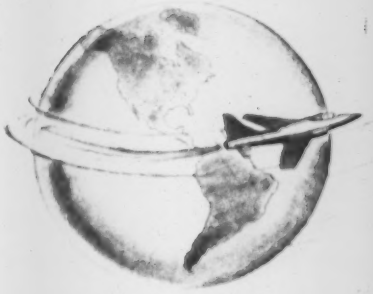

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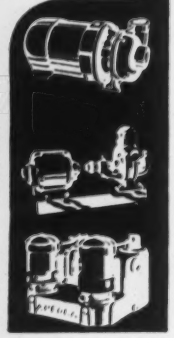

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KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

Metalworking Technique

A new process for making wrought products from metal powders has been developed by research engineers of the Sintercast Corp. of America, Yonkers, N. Y.

The company says that by this method, the known advantages of powder metallurgy—the ability to "tailor" compositions of metallic mixtures to specific requirements—are achieved in shapes such as strips, bars and tubes of long lengths hitherto unobtainable by powder metallurgy.

Know as "Sinterwrought," this new process eliminates many of the disadvantages of conventional powder metallurgy techniques and of conventional coasting and metal-working, the firm states.

Contrasted with conventional metal powder products, Sinterwrought products have greater strength and ductility, the company claims. The new wrought products are said not to contain the impurities present in the cast billets from which conventional wrought materials are made. Extremely precise control of composition can now be achieved with the process. Critical metallic or non-metallic ingredients can be added to the compositions in a uniform dispersion. Metals handled by the new method include aluminum, copper, nickel, cobalt, carbon steel, stainless steel, and alloys of these metals.

The company says, recent experiments indicate that metals of increasing industrial significance, such as columbium titanium and zirconium, may also be handled by the technique.

Air-Over A-C Motors

Reliance Electric & Engineering Co., 1088 Ivanhoe Rd., Cleveland 10, Ohio, announces a new line of totally-enclosed air-over a-c motors to produce varying horsepower according to the application of varying air velocities.

This effect, the company reports, is accomplished by the cooling effect of the air flow over the motor frame created by the fan or blower it powers. Power output can thereby be increased without exceeding the rated temperature rise of the motor, the firm states. Features of the new line include cast iron ribbed frame construction, oversized double-shielded ball bearings, and metermatic lubrication with automatic grease relief. The company says other advantages lie in the fact that heavy formvar nylon coated magnet wire is used for coils, with six coats of special insulating varnish.

Connection is said to be simplified by the leads being numbered and indexed through a neoprene gasket between the frame and conduit box, with the indexing corresponding to the connection diagram on the nameplate.

The motors are available in the new NEMA frame sizes from $\frac{1}{2}$ through 30 hp and may be operated on 208 volt network systems. Normally supplied in non-ventilated construction, explosion-proof Class I,

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LATEST CATALOGS

Group D and Class II, Groups E, F, and G enclosures are also available. Other options include the choice of foot or footless mounting, NEMA C-face or D-flange brackets, and a mounting plate for a long connection cable instead of a conduit box.

Power Hand Tool

Chicago Wheel and Mfg. Co., 1101 Monroe St., Chicago 7, Ill., announces the development of a new Hi-Torque Handee, Series 6000.

Among the features claimed for the tool are extra speed and power, streamlined design, larger air vents to permit increased air velocity for cooler operation, larger oilite bearings, and built-in chuck lock.

The new unit was developed for use as a complete hand workshop for machine shops, tool and die plants, foundries and household maintenance, master craftsmen, homecrafters and hobbyists. The unit weighs 14 ounces and operates at 25,000 rpm for grinding, cutting, carving, drilling, sanding, sawing, engraving, polishing, cleaning and burnishing.

The tool works in wood, hardened steel, non-ferrous metals, glass, ceramics and plastics. It is available for operation at 110 or 220 volts, 25 to 60 cycles, a-c or d-c and has a complete set of all-purpose accessories and steel carrying case.

Drill Length Reamers

Ace Drill Corp., Adrian, Mich., offers a line of drill length reamers in standard sizes ranging from $^1/_{16}$ to $^1/_2$ in. in diameter, by 64ths.

Recommended by the company for machining ferrous materials on drill presses or automatics, the reamers are made of pre-hardened HSS and produced by the ground-from-the-solid process to a tolerance of +.0002 —.0000 in.

According to the company, the fluting is nearly twice the length of regular chucking reamers.

Special diameter drill length reamers made from high speed steel drill blanks can be supplied in sizes .040 to .500 in.

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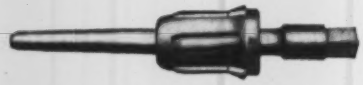

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(34)

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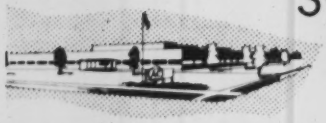

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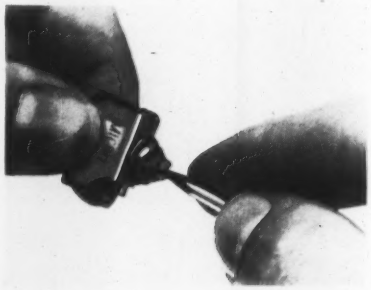
KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

Pressure Gage Testers

Amthor Testing Instrument Co., Inc., 45 Van Sinderen Ave., Brooklyn 7, N.Y., announces dead weight pressure gage testers, available in multiple piston models, to allow low-pressure and high-pressure testing in small increments.

Literature describing the equipment is available from the company.



Subminiature Switch

A new switch that can be installed in limited-access areas and actuated by a screwdriver is being marketed by Micro Switch, Freeport, Ill., a division of Minneapolis-Honeywell Regulator Co.

The compact switch is described as especially handy for installation in out-of-the way places, or where a switch needs to be operated only occasionally, such as when testing circuits.

It can, for example, be installed deep inside of equipment and operated only when desired by inserting a long screwdriver through an access hole, the firm states. This can eliminate the cost of mounting a switch on top of a chassis, or on a panel, and can save panel space as well, it is pointed out.

Designated the 1RAl, the new switch is a subminiature single-pole double-throw assembly. It has a slotted actuator head, with 90-degree rotation, that gives visual indication of switch position. Its bushing permits one-hole mounting in panels up to $^{3}/_{32}$-in. thick.

The subminiature basic switch is used as the precision switching element of the 1RAl. The assembly is available with such variations of the subminiature switch as high-temperature versions, long-life versions, and variations equipped with special terminals.

The company says other types are planned that will make the assembly available with extra length actuator shafts, either slotted for use with a screwdriver or plain for use with knobs. For hand operation without knobs, knurled or splined actuator shafts of different lengths can be provided.

The new switch is listed by Underwriters' Laboratories, Inc. for 5 amperes 125 or 250 volts a-c, or 3 amperes inductive at 30 volts d-c.

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Reactor Monitoring Services

Tracerlab, Inc., 130 High St., Boston 10, Mass., has announced its entry into the field of reactor monitoring instrumentation and services.

Included in this category are sight surveys, selection and construction of monitoring equipment, health physics services and training courses for personnel engaged in reactor and fuel fabrication programs, waste disposal and read iochemical work.

The company says complete monitoring instrumentation now available is in use at various reactors and includes air, water and gas monitoring systems, both mobile and stationary, leak detectors, survey instruments. One unique feature of this system is the building block principle—standard components can be put together to build a system which meets individual requirements, thus minimizing initial costs, the firm states.

Industrial Air Drill

A new industrial air drill, S-P 1000, has been announced by Superior Pneumatic & Mfg., Inc., 4758 Warner Rd., Cleveland 25, Ohio.

The drill has 1/4 in. capacity, a safety chuck shield, produces 2500 rpm and has 1/4 hp at 90 lb pressure. An exclusive patented metering trigger gives positive rpm control from 0 to 2500, the firm states.

According to the manufacturer, the tool weighs only 2 lb. The manufacturer also states that simple design, nickel steel gears and preloaded sealed bearings all combine to reduce maintenance costs to a minimum. The air drill is available with pistol grip or straight handle.

Boring, Turning Machines

American Steel Foundries, King Machine Tool Div., 1150-B Tennessee Ave., Cincinnati 29, Ohio, announces redesigned and re-engineered vertical boring and turning machines that are fully electrical in operation. All controls are located on the movable pendant station on an auxiliary control panel mounted on the machine.

Both feeds and speeds are pre-selective from direct-reading dials. Ranges of feeds and speeds have been expanded, providing 24 feeds from .0016 to .250 per table revolution, and 24 speeds in any one of three standard ranges: low, intermediate, or high.

Horsepower has been stepped up to a range of 40 to 50 hp on 30, 36 and 46 in. sizes, 75 to 100 hp on sizes 56 in. and up, the company reports.

According to the firm an improved spindle and spindle mounting provide maximum table stability with resultant increased machining accuracy. Unit construction of spindle drive is designed for easier maintenance and anti-backlash nuts are used for all cross-feed movements. Automatic lubrication is provided on all moving parts.

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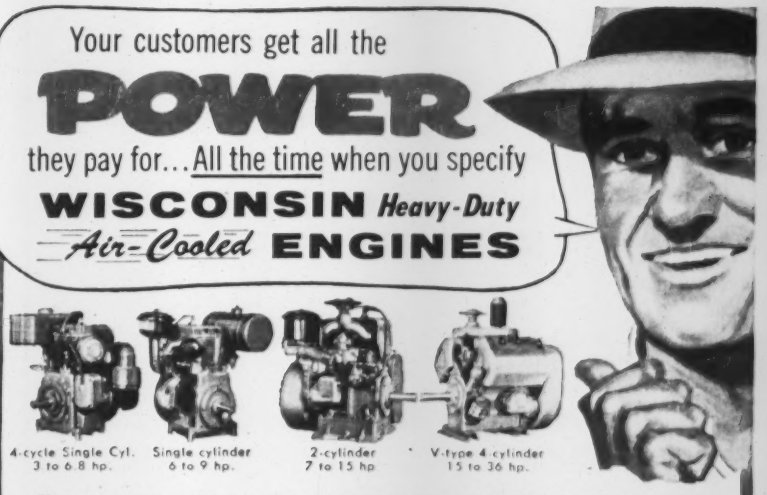

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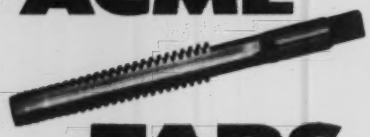

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DESIGNERS

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Lignin Sulfonate

Orzan P, a new member of a group of surface-active, lignin sulfonate chemicals for industry, is now being marketed by Crown Zellerbach Corp., Camas 4, Wash.

According to the company, the new chemical has the unusual property among lignin sulfonates of precipitating readily from solutions and clinging to fibers or other materials present. It is a spray-dried powder and may be precipitated from even dilute solutions by the addition of alum. Recommended uses are as a binder for fibers, retention of fines, an emulsifier, an emulsion stabilizer, a flocculant, and a dispersant.

The firm says the Orzans are derived from the chemically significant noncellulose portion of the tree, the spent liquor resulting from the manufacture of paper by the sulfite process. Lignin sulfonates have an outstanding ability for dispersing particles in water and holding them in suspension, the company states.

Wood is made up of almost 50 per cent cellulose and almost 50 per cent lignin and tree sugars, the company explains. Sulfite paper is produced from the cellulose. Water is evaporated from ammonium or sodium lignin sulfonate in the spent liquor to produce Orzan in the form of a powder with the appearance of instant coffee, or a brownish concentrated solution.

Field Coil Insulating

An "integrated" field coil with a newly developed insulating system designed to protect electric motors and generators against atmospheric contaminants and destructive mechanical forces has been announced by Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.

According to the company, integrated field coil construction is particularly well suited for applications requiring chemical resistance, oil and moisture-proofness, or sealing against atmospheric contaminants such as carbon black, dust and dirt. It is currently available for synchronous and d-c machines subject to severe duty cycling in Class A and B temperature classifications. Studies indicate, however, that the system will eventually be available for Class H temperature applications, the firm states.

Primary insulation in the integrated field coil construction is glass with fibers tailored and oriented for maximum strength. Solventless types of inorganic, heat stable resins augment the glass fibers.

These resins bond so well with coil conductors and pole surfaces that the structure is fused together into one integral part, the company says. The enveloping skin is inseparably locked with the coil and tightly pressure molded to coil contours.

This construction, the company says, results in dimensional stability, mechanical strength and durability, toughness and resiliency, oil and moisture-proofness and chemical resistance. It can withstand the

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Gives safety requirements relating to the design, construction, operation, installation, tests, maintenance, alterations, and repairs of hand and power passenger and freight elevators, hydraulic elevators, power and hand sidewalk elevators, private residence elevators and inclined lifts, dumbwaiters, and escalators.

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destructive forces of vibration and thermal shock, and requires little or no maintenance.

The new integrated field coil construction is described in leaflet 05R8525, available from the company.

Right Angle Nutsetters

A new line of right angle nutsetters in capacities up to $\frac{1}{2}$ in. bolt size has been announced by Thor Power Tool Co., Aurora, Ill.

The company is offering the new rotary air right angle nutsetters with direct drive in six models and two types: No. 4RDC heavy-duty type in speeds of 350, 600, 1100 and 1300 rpm and No. 4RDXC models in speeds of 800 and 1300 rpm. The latter two models are equipped with smaller proportioned right angle attachments for use in close quarters.

The new tools have unit type attachments, interchangeable from one machine to another. In addition, all bearings in the attachments are anti-friction. The cylinder housing is an aluminum alloy casting in one piece with a straight throttle handle.

The motor is a five-blade type with an alloy steel one-piece rotor and shaft. Friction is said to be cut to a minimum in the new models because the rotor actually runs in space on its bearings.

According to the company, distinctive feature of the new models is lengthwise slotting of the gear case at 90 deg intervals. The angle type nut setting attachments are keyed to these slots, permitting positive locking of the attachment.

The line includes an oil reservoir in the throttle handle for automatic lubrication of rotor blades and cylinder bushings. Gears and rotor, gear case and attachment bearings are grease lubricated.

Thin-Wall Welded Tubing

A new process for forming and welding of very light gage tubes in continuous lengths from high tensile cold rolled alloy strip, has been developed by the Universal Tube Corp., 2133 S. Kedzie Ave., Chicago 23, Ill.

It is claimed that the process provides such advantages as continuous lengths to 200 ft., better mechanical properties for corresponding metal thicknesses and diameters, and lower cost than seamless drawn tubes in equivalent sizes.

Very light gage welded tubing is now available in stainless steel, carbon steel, titanium, brass, bronze, and other weldable alloys, in wall thickness graduated from .005 for $\frac{1}{4}$ in. OD to .015 for $1\frac{1}{4}$ in. OD. It is expected that light gage tubing in larger diameters and in wall thicknesses below ratios of $\frac{1}{2}$ per cent of tube diameter will be made available in the very near future, the firm says. Stainless steel tubing (types 321 or 347 alloy) made by this new process conforms to U. S. Government specifications MIL-T-6737A for aircraft pneumatic duct, for high pressures, temperatures to 1500 F, and corrosive conditions, the company states.

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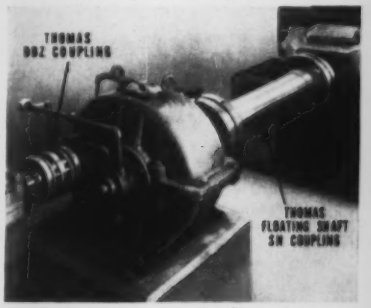

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OUTDOOR (Weather Resistant)
HAZARDOUS LOCATIONS (Explosion-proof)

ALL MERCOID CONTROLS INCORPORATE SEALED MERCURY CONTACTS

ASK FOR CATALOG NO. 857-P

THE MERCOID CORPORATION
4201 Belmont Ave., Chicago 41, Ill

KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Data Processing System

Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif., announces what is described as the first industrial data processing system capable of computing and logging secondary operating guides for industrial processes. The new instrument is called the "112" data processing system.

Simplified logic circuits, completely transistorized for dependability and long life, have been incorporated in the data system itself. Heart of the new instrument is a unique computing analog-to-digital converter. A single CADC is said to be capable of handling hundreds of channels of incoming information from thermocouples, pressure gages, stream-analysis instruments.

This data, in the form of electrical signals, is automatically sorted, stored, converted to digital numbers, or combined in complex mathematical formulas. The output in every case is in the form of simple numbers, easy to read, accurate to three figures, and ideally suited for production control, the firm states.

Rotary Drill

A new unit in its rotary drill line is announced by Davey Compressor Co., Kent, Ohio.

Designated as Model M-8AL, and equipped with a special long drill bar and mast, it can drill 24-ft ledges without changing steels, the firm says. It is suitable for mounting on any standard truck, and utilizes both compressed air and high-pressure water for drilling. It has a rated capacity of 6 1/4 in. holes up to 600 ft with air and 1500 ft with mud. In operation it is said to effect substantial savings in drilling costs.

Compressor for air blast drilling is a 500 cfm unit. High-pressure water pump is heavy duty duplex type. Compressor and pump are driven by a GMC-471 engine mounted on the truck bed. A 5-speed transmission permits operation of the drill at its most efficient speed.

The new Model M-8AL is recommended for shot and blast holes, structure testing, core drilling. It is also suitable for water well drilling. Weight of the complete unit is approximately 26,000 lb.

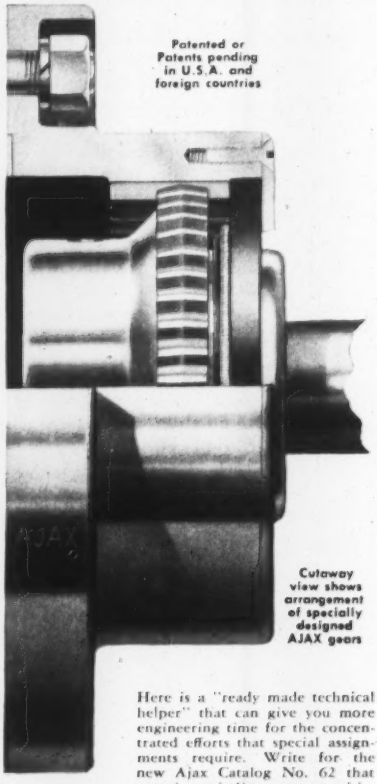
Hydraulic Power Unit

A complete, compact, self-contained hydraulic power unit, consisting of a 6 (or 12) volt d-c motor drive, pump, control valve and tank, and designed for applications on mobile equipment, snow plows, hoists, booms, tail gates, is now in production by Wisconsin Hydraulics, Inc., 3165 N. 30 St., Milwaukee 16, Wis.

The reservoir, for 110 cu in. of oil, is a rectangular housing of cast aluminum. An electric motor is flange-mounted to one end of the housing and the pump control valve to the opposite end. All working parts are totally enclosed and permanently lubricated.

AJAX®

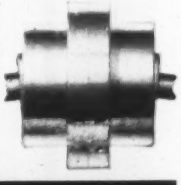
Self-aligning
DIHEDRAL COUPLINGS
Give Design Engineers An Immediate Source of Product Improvement


Patented or Patents pending in U.S.A. and foreign countries
AJAX
Cutaway view shows arrangement of specially designed AJAX gears

Here is a "ready made technical helper" that can give you more engineering time for the concentrated efforts that special assignments require. Write for the new Ajax Catalog No. 62 that contains misalignment capacities of every coupling size and type in the complete line of Ajax Dihedral Couplings. Why spend valuable time duplicating data already established by thousands of proven, field tested applications.

Ajax Dihedral Couplings handle unavoidable shaft misalignment, angular and offset, up to a total of 12°. Teeth can be cut to handle greater misalignment capacities on special order.

Get the facts on how manufacturers of presses, machine tools, rolling mills, cranes, earth moving and many other direct connected machines are simplifying design, cutting manufacturing costs and improving product performance with Ajax Dihedral Couplings.



Write today for your personal copy of Bulletin No. 62.

AJAX FLEXIBLE COUPLING CO. INC.
WESTFIELD, NEW YORK

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

The one-lever control can accommodate a clevis for remote control linkage, the company states. It has three operating positions—raise, lower and spring-return to hold. Lowering control is through a throttling valve for varying the rate of return. The unit may be mounted vertically, with motor end up, or horizontally. The combination fill cap and air intake has a renewable cartridge-type air filter.

BUSINESS NOTES

Acquires Meridan Unit

Flexonics Corp., flexible metal hose manufacturer, has acquired the Flex-O-Tube Div., Meridan Corp., Inkster, Mich. The division, which makes couplings and hydraulic hose assemblies, is being operated as a division of Flexonics.

Vibration Mount Distributor

Robinson Aviation, Inc., Teterboro, N. J., announces the appointment of Strong, Carlisle Hammond Co., Cleveland, as exclusive distributor in northeastern Ohio. It will distribute all-metal industrial mountings for shock and vibration control for machine and other industrial equipment.

Named Pump Distributor

Tuthill Pump Co., Chicago, announces the appointment of Paquin Co., 13405 St. Clair Ave., Cleveland 10, Ohio, as the exclusive sales representatives for Tuthill in the northern half of Ohio exclusive of Toledo, and counties west and directly south of Toledo.

Tuthill manufactures internal gear rotary pumps for hydraulic, lubrication, coolant, and liquid transfer services.

Capitol to Expand

Capitol Products Corp., which recently acquired Read Standard by merger, plans increased expenditures in new equipment, design development and expanded sales and service organizations, the company has announced.

The Read Standard Div. will continue its current operations as long as there is a demand for superior bakery equipment, chemical equipment, industrial blowers and stoker parts, the firm states. The merger joined a 52-year-old firm with a 4-year-old firm. Capitol Products was founded in 1952 in Harrisburg, Pa. Initially, it made only combination storm and screen doors, but its product lines have lately expanded to include storm windows, prime windows and aluminum extrusion. Established with $1,000 in capital and a $3,500 G.I. loan four years ago, Capitol has a current annual sales volume of $12,000,000.

Paragon® gives you speed . . . without fatigue!

Check the response-to-the-touch. You can actually feel the difference!

That's why the Paragon Drafting Machine noticeably cuts end-of-the-day fatigue . . . saves costly man hours . . . helps raise working standards.

See how easily protractor control ring can be reached—no matter what position your hand is in. Another time saver. Touch that ring with your *little* finger and scales rotate freely. Release pressure and scales automatically lock to nearest 15° position. And intermediate angles are just as easily set!

Top day-to-day performance is guaranteed by unique "open center" design of arms which protects smooth-working factory-set band tension.

A good look at a Paragon and a touch on that control ring is worth 1,000 words! Try it before you buy *any* drafting machine—you can *feel* the difference.

89 YEARS OF LEADERSHIP

In equipment and materials for drafting, surveying, reproduction and optical tooling . . . in slide rules and measuring tapes.

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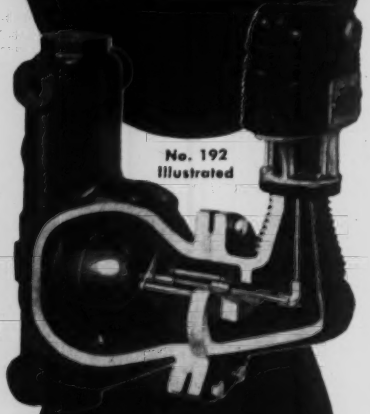
Yes...

McDONNELL CONTROLS FOR BOILERS TO 250 psi.



McDONNELL
92 SERIES
Pump Control, Cut-Off and Alarm Switch
Underwriters Listed

Here's a whole new concept of control design and performance . . . with the best-known name in its field. Introduces repulsion magnetic switching, for positive opening and closing. Beats the heat as never before—okayed for 75° C. (167° F.) wiring. Has extra generous float clearances; operating levels that are not affected by pressure changes, and a host of other refinements.

Write for Bulletin L-123

Shows 92 Series models with or without integral water column. Has full engineering data for controlling pumps or electric valves on boiler or tanks, for low water cutoff and alarm, etc.

Also shows companion 91 Series, for pressures to 150 psi.

McDONNELL & MILLER, INC.
3510 N. Spaulding Ave., Chicago 18, Ill.

McDONNELL
Boiler Water Level Control

KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

Topp Acquires Heli-Coil

Acquisition of all assets of Heli-Coil Corp., Danbury, Conn., manufacturer of wire screw thread inserts and other fasteners, by Topp Industries, Inc., Los Angeles electronics firm, is announced.

Plans are progressing for integration of Heli-Coil as an entity in Topp Industries and its research and development subsidiary, Haller, Raymond & Brown, Inc., State College, Pa. The combined companies have a total of approximately 900 employees and 125,000 square feet of factory, laboratory, and office space with headquarters in Los Angeles.

Electrical Products Sales

A special Electrical Products Sales Div., has been established by the Permacel Tape Corp., New Brunswick, N. J.

Permacel markets a line of pressure sensitive and heat curing tapes used for electrical insulation purposes and a number of epoxy resins, slot insulations, and Teflon films. The company also produces certain tapes used in the production of printed circuits.

Buys Die Casting Firm

Purchase of the die casting firm of Stemac, Inc., Denver, by the C. A. Norgren Co., Englewood, Col., is announced.

The Stemac firm produces such die cast items as industrial and automotive nameplates, hose couplings, door stops, and other items for concerns throughout the United States. Stemac also has been a supplier of high quality die castings used in Norgren products for several years. The firm employs about 60 workers.

Opens Indianapolis Office

Fischer & Porter Co. announces the opening of a sales office in Indianapolis, Ind. The new office will cover all territory in Indiana except counties in the northwest, which will be serviced from Chicago, and counties along the southern border, which will be serviced from Cincinnati. The address of the new office is 3025 North Illinois St., Indianapolis 8, Ind.

Hi-Trim Potentiometer

Announcement has been made by Borg Equipment Div., George W. Borg Corp., of the purchase of the Aerovox Hi-Trim Potentiometer product. Borg has purchased the tangible and intangible assets of this division located in Monrovia, Calif. It is being moved to the Borg Equipment Div. plant at Janesville, Wisconsin.

Manufacturing and assembly lines are being set up at Janesville where orders for these trimming potentiometers under the Borg Micropot trade name are already being processed.

BINDERS

For Your Codes and Standards

These Binders are well constructed, open flat; hold the publications firmly; and permit insertion, removal and transposition of contents easily. They are made of durable cloth, have identifying title stamped on the spine, and are 9" x 12" in size.

The Binder for the ASME Boiler and Pressure Vessel Code has a four inch capacity and is equipped with twelve flexible steel rods. That for Standards and Codes has a three inch capacity and holds from twenty to twenty-five pamphlets.

$3.25 Each

20% discount to ASME members.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 W. 39th St., New York 18, N. Y.

PAST EXAMINATIONS
for Professional Engineers given by New York State

This pamphlet contains the questions given in 1952-1956 examinations. They cover problems in structural planning and design, in practical applications of basic engineering sciences, and the more advanced and specialized problems in practical applications of engineering principles and methods.

$2.00 (20% Discount to ASME members)

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 W. 39th St., New York 18, N. Y.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Announces Name Change

DeZurik Shower Co., Sartell, Minn., is placing into operation several substantial new additions to its plant which culminate a record of expansion during the firm's quarter-century of operation. At the same time, the company announces a change in its corporate name to DeZurik Corp.

Primary among today's DeZurik products is an eccentric-type non-lubricated plug valve, ranging in size from ½ through 20 in. and produced in an extensive line of types and body metals. These valves are used in almost all industrial fields, including pulp and paper making, chemical processing, mining, petroleum, water, sewage and other industries, the company reports.

LATEST CATALOGS

Computer Bulletin

A six-page illustrated bulletin describing the G-15D general purpose digital computer and its digital differential analyzer accessory, is available from Bendix Computer Div., Bendix Aviation Corp., 5630 Arbor Vitae St., Los Angeles 45, Calif.

The versatility and range of operations of the basic unit is said to be considerably increased by the addition of this optional accessory. Linear and non-linear differential equations are solved accurately and rapidly with the two units, it is claimed. New programming techniques and input and output equipment are described.

Fittings, Adapters

Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio, announces catalog 4360 showing straight thread plugs and adapters, o-rings for straight thread fittings, and steel brass pipe fittings.

Bag Conveyor

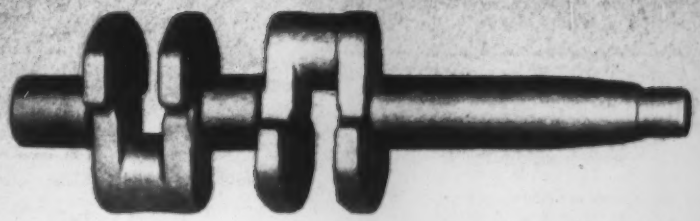
A new adjustable-length flat belt bag conveyor designed for package conveying, particularly in line with filling and sewing operations, is described and illustrated in a new four-page, two-color bulletin, No. 0456, offered by Richardson Scale Co., Clifton, N. J.

The bulletin describes operation of the conveyor, which coordinates bag packing and sewing into a single one-man operation. A key feature is the conveyor's "telescope" design, which gives the user a choice of conveying lengths from 7 to 12 ft.

Use a CLASSIFIED ADVERTISEMENT *for Quick Results*

How often do you find a flaw in a coin?

...or in a FORGING?



(Both are made by the same basic process)

When closed impression dies strike a coin, or hammer out a forging, they produce a result that gives specific advantages — **freedom from concealed flaws, closeness to tolerance, strength without bulk, superior resistance to impact and fatigue stresses.** These advantages mean fewer part rejects, greater overall economy, better product dependability and performance. These advantages are all found in forgings, **the metal you can trust.**

Do you have a part design problem? Are you now purchasing parts, made by other processes, which require extra metal to provide strength? Are you using weldments, or fabricated assemblies? You will find that often forgings can eliminate extras, and yet give you quality-plus advantages.

Make it a point to call in a forging engineer to learn more about how up-to-date methods and techniques of forging can help to reduce your products or part cost.

Reduce your cost by using forgings. Send for booklets, ☐ "What is a Forging?" and ☐ "Management Guide to the Use of Forgings."

closed-die **forgings** for metal you can trust

DROP FORGING ASSOCIATION

Dept. ME, 419 S. Walnut St., Lansing, Mich.

Symbolic emblem of the Drop Forging Association

TAKE YOUR PICK!

Special Chromalox features solve 3 spot heating problems

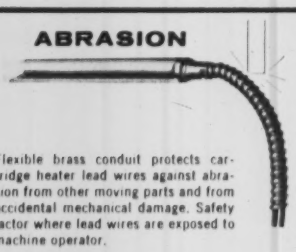
FLEXING

Spring strain reliever of high temperature stainless steel for applications in which cartridge heater leads flex. High tensile spring, mechanically locked to heater, covers lead wires a distance sufficient to distribute stress.

MOISTURE

Moisture-resistant flexible brass conduit protects lead wires of cartridge heaters operating in presence of steam, water, oil and vapors. Also offers added protection from flexing, vibration and mechanical damage.

ABRASION



Flexible brass conduit protects cartridge heater lead wires against abrasion from other moving parts and from accidental mechanical damage. Safety factor where lead wires are exposed to machine operator.

FREE BULLETIN!

CHROMALOX ELECTRIC CARTRIDGE HEATERS

Get the full story. Call your Chromalox Representative or write today for Bulletin 850.

C-2101

Edwin L. Wiegand Company

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KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

Plated Wire Characteristics

Specifications and characteristics of Nickelply and Brassply electro-plated steel wires are described in an eight-page illustrated booklet issued by National-Standard Co., Niles, Mich.

The wires are drawn and plated with nickel or brass coatings that do not separate from the base metal under severe twisting, bending, flattening or roll-threading operations. They are used by fabricators of wire goods where product appearance or corrosion resistance are essential.

Traffic Paint Film

A new film depicting methods for selecting and applying traffic paints is now available from Hercules Powder Co. Wilmington 99, Del. The 16-mm. film "Highway Life Lines" is in sound and color and runs for about 16 minutes.

Against a backdrop of highway scenes from coast to coast, the film covers subjects such as methods of evaluating traffic paints; factors influencing paint performance; and various methods of applying traffic paints.

Nuclear Reactor Bulletins

Bulletins describing the aqueous homogeneous burner reactor and a tank-type research reactor have been issued by Foster Wheeler Corp., 165 Broadway, New York 6, N. Y.

Bulletin N-56-8 describes the operation of the aqueous homogeneous power plant, its auxiliary system, biological shield and containment, and includes a cross-section and flow diagram. The operation and research facilities of the tank-type reactor are described and illustrated in Bulletin N-56-9.

Small Seamless Tubing

Uniform Tubes, Inc., 1200 Level Rd., Collegeville, Pa., has published a four-page general catalog covering its line of small seamless tubing and small tubular components. The firm draws seamless metal tubing in all popular analyses in sizes from .005 to .625 in. OD, with walls from .0010 to .065 in. The company also offers forming and machining facilities and manufactures small tubular components on a short or long run production basis.

Alloy Chain Data

S. G. Taylor Chain Co., Inc., Hammond, Ind., has published a wall chart to be used as a guide in the proper use of alloy chains and alloy slings.

The 22 × 28 in. chart features a table giving the working load of single, double, triple and quad branch slings—sizes 1/4 to 2 in.—when used at 90, 60, 45, 30 and 10 deg angles with the load. In addition, the chart provides definitions, instructions, and cautions governing the purchase and use of chain as well as data on inspection, wear, and the use of chain under heat conditions.

CANCER LIFE-LINE

Through films, pamphlets, posters, exhibits and lectures, our life-line of cancer education reaches men and women in business and industry.

They learn facts about cancer which could mean the difference between life and death. For additional information about a program in your plant call the American Cancer Society or write "Cancer" care of your local Post Office.

AMERICAN CANCER SOCIETY

VISCOSITY OF LUBRICANTS UNDER PRESSURE

This Report reviews twelve experimental investigations made in England, Germany, Japan, Russia, and the United States on 148 lubricants comprising 25 fatty oils, 94 petroleum oils, 17 compounded oils, and 12 other lubricants. Data collected are co-ordinated by means of sixty tables in which the results originally appearing in diversified units are compared. The methods proposed for correlating viscosity-pressure characteristics of oils with properties determined at atmospheric pressures are reviewed and illustrated. Pertinent topics such as experimental work on heavily loaded bearings, lubrication calculations, and additional techniques for viscosity are covered. Conclusions and recommendations are presented. Other sections give the required computation of temperature and pressure coefficients, a bibliography of 189 items, and symbols.

1954 **$5.00**

(20% Discount to ASME Members)

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

29 W. 39th St. New York, 18.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Selection of Coatings

The 1957 Coatings Manual, described as a treatise highlighting the stopping and preventing of rust on nearly all types of rustable metal throughout industry, home and farm, is now available from Rust-Oleum Corp., 2799 Oakton St., Evanston, Ill.

The new treatise features the results of over two years of intensive research by engineers and local technicians in areas where conditions of excessive moisture, salt spray, fumes, gases, weather, and other rust-producing agents are severe. It contains information and recommendations for determining specific coatings needed to protect practically any rustable metal surface.

Teflon Equipment

Haveg Industries, Inc., 900 Greenbank Rd., Wilmington 8, Del., announces publication of a four-page bulletin on Teflon as it applies to its equipment now in production.

The illustrated brochure, T-50, the first of a series, covers this plastic resin as a material. It details properties. Applications include thin- and heavy-walled tubing and rod, steel pipe lining, insulated wire, machine parts, and sheet.

Stainless Castings

The second edition of the booklet "Stainless Castings" has been released by Allegheny Ludlum Steel Corp., 2020 Oliver Bldg., Pittsburgh 22, Pa.

This 28-page booklet gives information on corrosion-and-heat resisting stainless steel castings. A special category in the booklet entitled "Technical Data Section" gives information on physical properties and chemical composition-standard analysis on stainless steels used in casting.

Writing Oscillographs

Offner Electronics Inc., has issued a 12-page, two-color catalog describing the firm's new Dynograph recorder models.

The Dynograph is said to be a high-speed direct writing oscillograph for the recording of a variety of dynamic and static variables that combines in one unit, three media of recording; ink, heat sensitive, or electric sensitive with either curvilinear or rectilinear coordinates. Described are the principles of operation, specifications, assemblies and construction of four units.

Blast Room

The Vacu-Blast Room, for low cost cleaning of castings with high visibility, achieved through efficient downdraft ventilation is described in a leaflet published by the Vacu-Blast Co., Inc., Belmont, Calif.

A patented waffle-type floor is said to permit rapid removal of abrasive from the room. The abrasive is removed from the blast room by the air that ventilates the room, is completely air washed and is returned to the continuous blast generator in a closed system.

FIGHT VIBRATION WITH VIBRATION

New twist in testing ...a torsional exciter

TORSIONAL testing *has* been done with rectilinear motion shakers by applying ingenuity in linking table to specimen. But here's a new MB exciter that produces torque *directly*. Its performance characteristics permit you to use it as a *calibrator* for torsional pickups and accelerometers . . . as well as for testing gyros and relays (as examples), or checking torsional vibrations of armatures, or determining torsional modes in various rotating parts.

OPERATING FACTS

At free-table, no load, this MB Model CA 1050 Exciter oscillates at up to 1600 cps without resonance in moving elements. It develops 110 ft. lbs torque, which produces angular accelerations as high as 1570 radians/sec/sec. Maximum total displacement is 45.

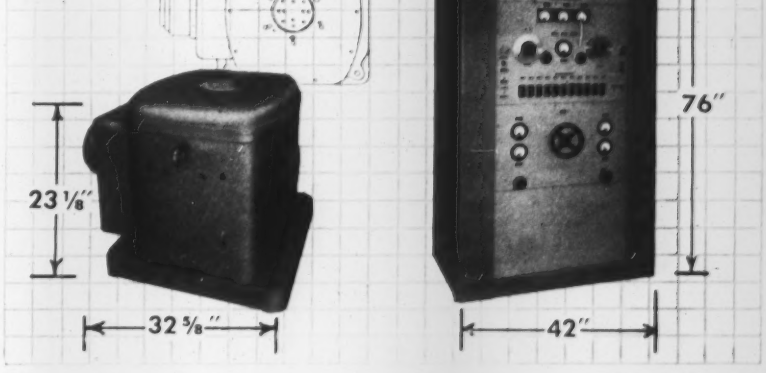
A MATCHED SYSTEM

Any one of several MB electronic power supplies drives the equipment, depending on the specific frequency range, power, and performance you want. The MB Model T51 Power Supply shown comes with automatic cycling controls if desired.

SEND FOR DETAILS

Technical data available. And for more information on how and where to use this unusual equipment, contact our staff of vibration specialists. You can't come to a better qualified authority on the subject . . . nor to one more willing to help on your specific vibration testing problems.

MB *manufacturing company*
A DIVISION OF TEXTRON INC.
1074 State Street, New Haven 11, Conn.
HEADQUARTERS FOR PRODUCTS TO ISOLATE . . . EXCITE . . . AND MEASURE VIBRATION



ENGINEERS DESIGN MECHANICAL

INERTIAL GUIDANCE SYSTEM PROGRAM

- Vibration and Stress Analysis
- Mechanical Design
- Electronics Package Design
- Electronics Package Cooling

Work with the top men, in the most Versatile Laboratories and with the finest test, research and development facilities. New plant being added in suburban Milwaukee as part of Major, Permanent, Expansion Program.

AC provides financial assistance toward your Master's Degree. Graduate Program also available evenings University of Wisconsin, Milwaukee.

GM's aggressive position in the field of manufacture and GM's policy of decentralization creates individual opportunity and recognition for each Engineer hired.

Milwaukee offers ideal family living in a progressive neighborly community in Southern Wisconsin.

For personal confidential interview in your locale send full facts about self to

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Recent EE, ME Graduate Inquiries Also Invited

THE ELECTRONICS DIVISION
GENERAL MOTORS CORP.
Flint 2, Mich. Milwaukee 2, Wis.

KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Combustion Analyzer

Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio, announces the availability of a four-page product specification E65-5 describing the "Heat Prover" combustion analyzer which indicates per cent by volume oxygen and combustibles present in the exhaust gases from all types of boiler and industrial furnaces.

Operating and physical characteristics are provided, together with a list of accessories and helpful ordering information.

Estimating Chart

As an aid to estimating the amount of material necessary to insulate cylindrical vessels, the Armstrong Cork Co., Lancaster, Pa., has developed a chart for converting gallon quantities into square feet of surface area.

The chart was developed to eliminate complex mathematical calculations when vessels, such as domestic hot water tanks and expansion tanks, are designated only by gallon size, or by length and diameter.

Industrial Equipment

A 44-page catalog featuring air-powered reciprocating pumps and equipment for paint circulating systems, viscous material transfer, extrusion applications and spraying has been announced by Gray Co., Inc., 1045 Sibley St., N. E., Minneapolis 13, Minn.

The No. 453 Catalog illustrates and describes in detail air-powered Powerflo pumps for pumping, directly from original containers, material from light fluids to the most viscous mastics. Four complete series of pumps in varying power ratios are available.

Pinhole Detector

Bulletin GEA-6520, four pages, providing information on capabilities and operation of a redesigned pinhole detector for automatically inspecting fast-moving opaque strip for small holes, is available from General Electric Co., Schenectady 5, N. Y.

Compressor Bulletin

A revised "Reciprocating Compressor" bulletin is available from Trane Co., La Crosse, Wis. Included for the first time are ratings and data on the firm's 125 and 150 hp compressor and condensing units. Ratings on 60, 75 and 100-ton condensers have been revised to conform with a new and more efficient condenser, which incorporates water heads at both ends. The double-head design permits increased cleaning ease of condenser tubes, the company reports.

For Consulting Engineers Turn to Page 180

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
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Excitation Systems

A comparison of the four basic types of automatic excitation systems is given in an eight-page leaflet entitled, "Selecting Excitation Systems for Turbo-Generators," released by Allis-Chalmers Mfg. Co., 949 S. 70th St., Milwaukee, Wis.

The leaflet, No. 05R8530, lists the principal component parts used in each of the excitation systems and reveals their advantages and limitations.

Selector Valves

New developments in the firm's seal-tite selector valve line are presented in catalog 356A, available from Republic Mfg. Co., 15655 Brookpark Rd., Cleveland 11, Ohio.

The valves are designed for service for air, gases, hydraulic oil, non-aromatic fuel, petroleum, and water. Working pressures for air and gases are 0-500 psi; for liquids, 0-1000 psi. Operating temperature range is −65 to 160 F.

Rectilinear Recorder

Three illustrated bulletins on a rectilinear writing galvanometric recorder, the recti/riter, and accessories are announced by Houston Technical Laboratories, subsidiary of Texas Instruments Inc., 3609 Buffalo Speedway, Houston 6, Tex.

Bulletin R-501 is a six-page, two-color brochure detailing the design, construction and operator convenience features of the recti/riter, an ink-writing, strip chart recorder. Supplementary illustrated bulletins describe the recti/riter panel and shock mounts and the line voltage monitor attachment which converts the recorder to an expanded scale graphic voltmeter.

Push Button Switches

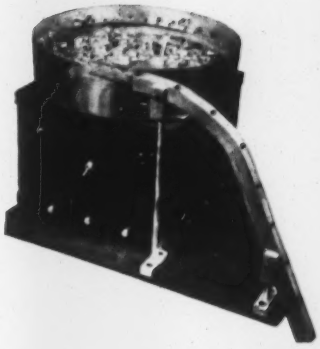
A four-page catalog, No. 200, covering its line of push button, lever and turn switches has been released by Donald P. Mossman, Inc., Brewster, N. Y.

Included are illustrations, ratings, dimensions and all specifications. A section is devoted to the company's electronics division which specializes in assembling and wiring of control panels, cableforms, to individual customer requirements.

Chromizing Process

A four-page reprint, "Chromizing for Resistance to Corrosion and Wear," is available from Chromalloy Corp., 45 Tarrytown Rd., White Plains, N. Y.

The article gives technical information on a number of applications of the ductile and the hard case produced by the firm's process in which chromium is diffused into the surface of steel parts. In addition to photographs and photomicrographs there are tables showing the types of base steels used, and the properties created by Chromallizing.

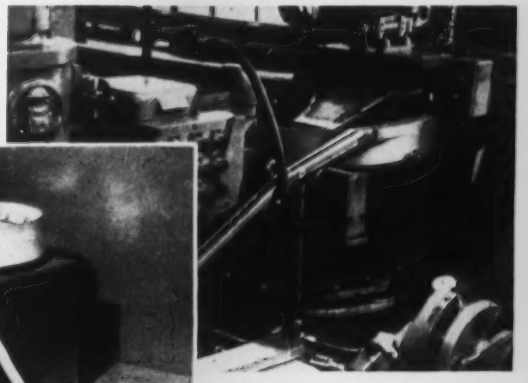


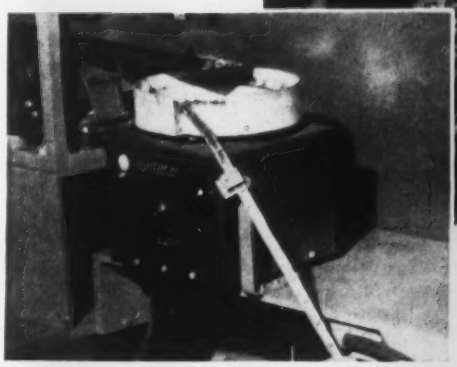
SYNTRON

VERTICAL-VIBRATORY

PARTS FEEDERS

Automatically feed and orient piece parts . . .



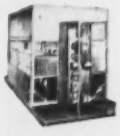


Controlled feed rates of parts to automatic machinery

SYNTRON Vibratory Parts Feeders have broadened the once limited field of piece parts handling. Syntron Parts Feeders with their unique, gentle vibrating action and rheostat controlled rate of parts flow allows the handling of very fragile parts, such as thin walled glass bulbs, easily shipped ceramic parts, explosives, etc. This is impossible with mechanical feeders. SYNTRON PARTS FEEDERS are designed for long dependable service and simple, low cost maintenance. Easily adaptable to any automatic machinery operation, assembly, counting, inspecting, packaging, etc., that require single file feeding of small parts. Send sample parts to SYNTRON application Engineers for recommendations.

Other SYNTRON Equipment of proven dependable Quality.

POWER CONVERSION UNITS



SELENIUM RECTIFIERS

INFRARED HEATING PANELS

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SYNTRON COMPANY

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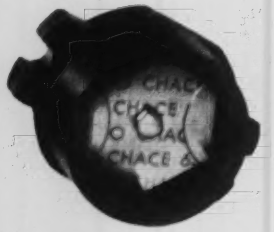
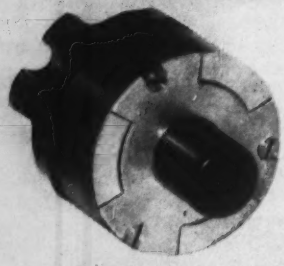
HOW CHACE THERMOSTATIC BIMETAL ACTUATES THE

RBM

MOTOR PROTECTOR

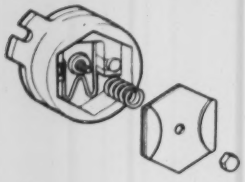


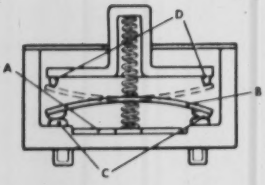
AUTOMATIC RESET—#91300, #91400



MANUAL RESET—#92300, #91400

A PRODUCT OF RBM DIVISION OF
ESSEX WIRE CORP.
LOGANSPORT, IND.





After years of development by RBM Division of Essex Wire Corp., and now in volume production, this bimetal motor over-load protector provides overload protection for split phase or capacitor motors such as are used in many household appliances. It may also be used with 110/220 volt motors of heavier capacity. The disc-type element is sensitive so as to give instant response to locked rotor current, yet carry starting surges and protect against running over-loads. The calibration to trip at 105° (also 120°) allows for ambient compensation for varying temperatures within the motor. The box shape of the terminals prevents soldering spatter and the double break contact provides long contact life. The snap-action disc element is fabricated from Chace Thermostatic Bimetal.

Here's how the manual reset protector works: The heater wire (A) carries a normal load but is heated by locked rotor currents or running overload currents. The heater in turn heats the thermostatic bimetal disc element (B) until at the calibrated temperature it snaps into the reverse shape, opening the contact points (C); when the reset plunger is depressed after correction of the failure, the two buttons (D) contact the bimetal element, forcing it to snap back into its original shape with contacts closed.

Remember Chace when you design for temperature actuation or indication, or for protection of valuable equipment. Dependable Chace Thermostatic Bimetal is available in 28 types, in strip, coil or completely fabricated and assembled elements made to your specification. Write for new 44-page booklet, "Successful Applications of Chace Thermostatic Bimetal," containing interesting uses of bimetal and many pages of engineering data.

IT BENDS WITH THE HEAT

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Thermostatic Bimetal
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KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Vibration Eliminators

Availability of literature descriptive of vibration eliminators obtainable with a majority of its lines of air conditioning and refrigeration equipment is announced by Drayer-Hanson Div., National-U.S. Radiator Corp., 3301 Medford St., Los Angeles 63, Calif.

The rubber-in-shear isolators are shipped from the factory assembled to units, if so specified. Charts on the vibration eliminators indicate total number of eliminators required per unit, shipping weights, and include diagrammatic cross-sections of these molded mound-shaped components. Units are keyed to the firm's range of products for all models and coil arrangements.

Polyethylene Foam

Agilene-F, expanded foam polyethylene, is detailed in a new catalog sheet, published by the American Agile Corp., Box 168, Bedford, Ohio.

The material has a uniform small-sized closed-cell structure. It is offered in such semi-finished molded components as rings, blocks, rods and sheet, and can also be molded to shapes to meet individual specifications. Principal applications include those for gasketing, cap and closure linings, low-temperature insulations, industrial floats, sandwich cores, shock absorbers, packaging, buoys, radiation shielding.

Gas Liquefier

A six-page folder giving engineering data on the Norelco gas liquefier is available from the Instruments Div., North American Philips Co., Inc., 750 S. Fulton Ave., Mount Vernon, N. Y.

The bulletin is illustrated with photos and drawings which show the operating cycle and construction of the machine. Technical details cover speed, efficiency, yield, motor characteristics, cooling water consumption, weight and size. Information is included on liquid air applications. Liquefying of gases from cylinders is also discussed with respect to industrial problems. The folder also covers the economics and practicability of an in-plant source of liquid air when temperatures as low as −328 F must be produced.

Gear Checker

A bulletin highlighting the features of a new automatic-cycle gear checker is available from Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.

The two-page, two-color bulletin, No. 481-A, describes the equipment, its operation and its capabilities. Designed particularly for aircraft and special-purpose spur gears, the checking unit measures and records parallelism, tooth taper and tooth spacing. Readings are automatically and permanently recorded in two colors by a built-in recorder for easy evaluation. Accuracy, through a two-channel electronic circuit, is to 0.0001 in.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Oil Seal Engineering

Victor Mfg. & Gasket Co., Box 1333, Chicago 90, Ill., has released a new edition, No. 305, of its oil seal engineering catalog.

The 60-page catalog illustrates the standard designs available in the two primary classifications of oil seals: metal OD and rubber elastomer OD. It gives specific recommendations on design adaptability in relation to pressure, temperature, and shaft speed conditions. It groups under shaft sizes the various designs available, with a cross section of each design.

Permanent Magnets

Publication of a new technical bulletin entitled "The Newest of the Alnicos, Alnico 5Cb" has been announced by Thomas & Skinner, Inc., 1120 E. 23rd St., Indianapolis, Ind.

The bulletin gives a description of Alnico 5Cb, including its physical properties, dimensional limitations and a typical demagnetization and energy product curve. It also contains a description of the comparative properties of all the firm's standard permanent magnet materials.

Servo Components

Norden-Ketay Corp., Commerce Rd., Stamford, Conn., announces bulletin No. 410, describing high temperature servo mechanism components.

The units are available to meet customer specifications under high ambient temperature conditions encountered in airborne and nuclear applications.

Polyvinyl Chloride Eductors

Bulletin supplement 2M-PVC released by Schutte and Koerting Co., Dept. JA-1, Cornwells Heights, Pa., the company's new polyvinyl chloride eductors.

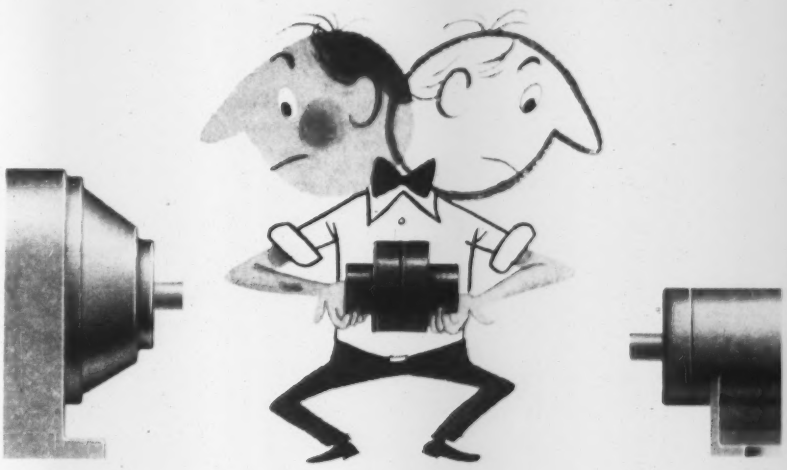
The eductor is recommended by the company for liquid pumping and mixing operations and, when particle size permits, the handling of solids. Performance characteristics are similar to those of the equivalent size standard metal units. This supplement includes tables of dimensions, capacities, and a partial list of recommended uses.

Rolling Mills

"Rolling Mills for Processing Nuclear Fuel Elements," a 12-page booklet published by Stanat Mfg. Co., Inc., 500 Shames Dr., Westbury, N. Y., discusses in detail the special equipment employed in rolling and fabricating the new metals required for the atomic energy program.

The text covers the solution of problems confronted in the nuclear field with regard to avoidance of radiation hazards and special rolling techniques. Included are photographs and descriptions of rolling mills as well as slitting and leveling equipment used in AEC installations and private companies involved in nuclear work.

why limit yourself to SHORT couplings?

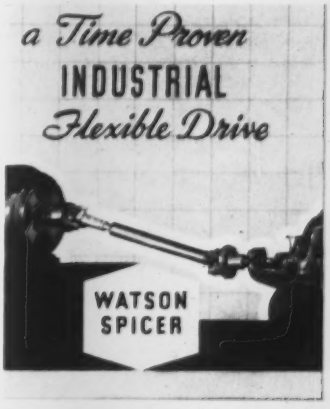


there is an easy way to
couple machines 1 to 50 feet apart

Watson-Spicer Flexible Shafts can transmit from 10 to 800 horsepower either horizontally or vertically. Putting extra distance between driving and driven machines allows you to solve many problems – elbow room for maintenance – better weight distribution – flexibility of space allocation – and extra reach from prime mover to machinery in pits or on elevated supports. Also, you can isolate engines or motors from dirt, moisture, fire hazards or contact with process materials.

You may be solving cost problems as well. Watson-Spicer Flexible Shafts greatly simplify alignment problems, eliminating need for costly common base plates and significantly reducing millwright time.

It's easy to recognize the places for flexible shafts – if you know the criteria. It's easy to choose the right sizes – if you have the engineering data. And they're easy to buy – if you know whom to call and what to specify. This is information that should be in your files. We'll be glad to send it, if you'll write and ask for Catalog F-2.



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1606 LASKEY ROAD, TOLEDO, OHIO

KEEP INFORMED

NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Tape Recorder

Capabilities and characteristics of the FR100 instrumentation tape recorder are described in a 20-page booklet published by Ampex Corp., 934 Charter St., Redwood City, California.

Numerous illustrations show transports, heads, and modular electronic assemblies used with the unit. Where necessary, graphs are provided to clarify specifications and recorder operation. The firm says the recorders are used in data acquisition, storage, analysis and reduction, in machine and process programming and in dynamic simulation. Data may be recorded and reproduced in the dc to 100-kc frequency range on one to 14 tracks at any of six standard tape speeds, $1^{7}/_{8}$ to 60 in. per sec.

Thermopiles for Conversion

A 12-page brochure describing Hilger-Schwarz thermopiles for conversion of infra-red energy into electrical energy suitable for amplification and measurement is available from Jarrell-Ash Co., 26 Farwell St., Newtonville 60, Mass.

Being introduced in the United States for the first time, these thermopiles are designed for applications in the fields of infra-red spectrophotometry, astronomical infra-red measurement, emission pyrometry, and as components of temperature control devices. The thermopiles are produced in both vacuum sealed and air types, and are available with a choice of four window materials—glass, quartz, fluorite or potassium bromide.

Valve Selection

A revised edition of "Guide for Selecting Valves, Boiler Mountings, Lubricating Devices" has been published by Lunkenheimer Co., Cincinnati 14, Ohio.

New sections, describing LQ600 bronze globe valves, with Brinalloy seats and discs; Luncor PVC all-molded valves; and solder end valves have been added to the 24 pages of tables, technical data and information.

Abrasive Cut-Off Machines

The firm's line of abrasive cutting machines is described in a four-page folder, Bulletin DH-460-B, released by the Campbell Machine Div., American Chain & Cable Co., Inc., Bridgeport 2, Conn.

Twelve models of varying capacities are pictured in the folder. Specifications such as model number, uses, floor dimensions, speeds are given in a comprehensive table. Data on Allison abrasive cutting wheels are also listed.

Stainless Steels

A publication entitled "Stainless Steels Types 308, 309 and 310" which have increased chromium and nickel content over stainless steel types 302 and 304, is being distributed by Allegheny Ludlum Steel Corp., 2020 Oliver Bldg., Pittsburgh 22, Pa.

The eight-page booklet contains such information as physical properties, heat treatment, strength at elevated temperatures, fatigue strength, and resistance to oxidation. The steels are used in furnace parts, boiler baffles, fire box sheets, oven linings, still tube supports, pump parts and kiln linings, the company reports.

150 YEARS OF PUBLISHING

LOOKING FORWARD

Robert Fulton's marvelous steamboat
fired the minds of forward-looking men
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NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Automatic Drives

Torque converter drives for lift trucks are described in specification sheets on the Hystamatic drive, now being made for lift trucks by Hyster Co., 2902 N. E. Clackamas St., Portland 8, Ore.

This transmission is available as optional equipment for the all-new 3000, 4000 and 5000 lb capacity 30, 40 and 50 lift trucks on pneumatics in addition to their "Space Saver" lift trucks of the same capacities on cushion tires. According to the company, the torque converter transmission allows positive "inching" control and allows combined "inching" and raising of load at full lifting speed. Low-high gear shifting is eliminated and synchronizer speeds forward-reverse shifting.

SR-4 Devices

A new line of flat grid, fine pitch, bakelite gages, described as superior replacements for small sizes of wrap-around gages, is among the new products listed in the new price list on SR-4 strain gages, instruments and accessories issued by the Electronics and Instrumentation Div., Baldwin-Lima-Hamilton Corp., Dept. 5086, Waltham, Mass.

The list contains a discussion of gages and methods of using them. Other products priced in the new list include several new, self-compensated gages, a high temperature and room temperature foil gage line and an assortment of special cement kits.

Alloy Cold Forging

A process for cold forging super alloys into virtually any shape is featured in a brochure available from Impact Products, Inc., Box 7, Orangeville, Ohio.

The process has been used successfully on S-816, Inconel 700 and 713, Udimet 500 and A-286, the company says. The four-page brochure points out that the new cold forging process also can be used on steel and aluminum. It describes the process and lists eight major advantages resulting from its use. Nine case histories of parts cold forged are explained.

Steel Springs

ALCO Products, Inc., Box 1065, Schenectady, N. Y., has available a 16-page bulletin on the company's production of hot and cold-wound steel springs.

The two-color publication describes the firm's experience in the spring producing industry at Latrobe, Pa. and later with the addition of a second plant at Chicago Heights, Ill. The bulletin describes adaption of automation techniques in producing springs, and contains formulas and specifications for helical extension springs and volute and Belleville disc springs. Also included in the book are two pages of design recommendations and a chart listing physical properties for calculating springs in 22 materials.

Reactor Booklet

Raytheon Mfg. Co., Waltham 54, Mass., has published a new, up-to-date edition of its reactor booklet, "Nuclear Reactor Data 2," which gives the important characteristics of 142 reactors located throughout the world.

Most of the information for the booklet was obtained directly from reactor designers and owners in the United States, England, Norway, Germany and other countries.

Expendable Pallets

Signode Steel Strapping Co., 2600 N. Western Ave., Chicago 47, Ill., offers an illustrated chart which describes the most efficient methods of handling expendable pallets of wood or non-wood construction.

It includes instructions for loading boxes on pallets, handling pallets by fork trucks and hand pallet trucks, and both truck and car-loading methods.

The Navy's newest submarine, USS Darter, built by Electric Boat Division, General Dynamics Corporation

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Are *your* drafting boards keeping pace with engineering developments? The installation of Universal Boardmaster drafting machines more than pays for itself in greater drafting efficiency and productivity. Precision accuracy and facility of operation are basic to Universal design. Ten exclusive construction features prove Boardmaster's time-saving, work-saving superiority. We invite you to write for this factual information.

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KEEP INFORMED

NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Electronic Products

Information on cathodes and other tubular electronic parts is incorporated in a revised catalog published by Superior Tube Co., 1715 Germantown Ave., Norristown, Pa.

Designated as Catalog No. 51, it describes two new additions to firm's line: the narrow neck disc cathode and Cathaloy P-51. Using a smaller ceramic than standard, the narrow neck disc cathode is said to permit manufacturers to produce cathode ray tubes with a narrower glass neck, thereby increasing the deflection angle of the tube to allow a shorter tube design. Cathaloy P-51 is a pure nickel alloy with four percent tungsten added for resistance to shock and vibration.

Free Operator's Booklet

"How To Operate A Lift Truck," a 24-page, two-color booklet, is offered by Hyster Co., 2902 N. E. Clackamas St., Portland 8, Ore.

The two-color cartoon technique is used and information about the operation of a lift truck, preventive maintenance, safety and basic materials handling is included. Drawings for setting up an obstacle course are also included.

Rubber Rolls

The maintenance of rubber rolls is the subject of Roll Report No. 11, recently published by Rodney Hunt Machine Co., Orange, Mass.

A table lists faults and the causes of faults commonly found in rubber rolls, together with recommended treatments. Also presented is a discussion of maintenance techniques, with recommendations about problems involving grooves, cracks and surface damage, lubrication, cleaning, transportation and storage.

Glass Fiber Insulation

L. O. F. Glass Fibers Co., 1810 Madison Ave., Toledo 1, Ohio announces the release of a product brochure, WPD-12, describing three kinds of flame-blown glass fiber insulations used for thermal and acoustical applications. Charts are included illustrating the acoustical and thermal values of Microlite, Super Fine, and Mocrotex insulating blankets.

In addition to the flexible and light-weight insulations, other company products, including Micro-Fibers, Micro-Quartz, plastics-reinforcing products, textile yarns and mat products are described.

Air-Cooled Compressors

A 16-page bulletin, showing a complete line of small, air-cooled compressors for industrial, automotive, commercial and general use, is offered by Gardner-Denver Co., Quincy, Illinois.

The compressors described are widely used for providing air for anything from hammers and hoists to vacuum cleaners and laundry presses, the firm states. Both one- and two-stage compressors are offered, with working pressures ranging from 85 to 175 psi. Models shown include bare compressors and those with horizontal and vertical tanks. The latter models are designed for use in limited space. Specifications for each model are given.

Cold Headed Fasteners

A four-page catalog covering the design and manufacturing advantages of cold headed fasteners and parts is available from John Hassal, Inc., Westbury, N. Y.

Text and illustrations show the design possibilities in rivet, nail and threaded part manufacture by the cold heading or cold forging process.

The ADDED Ingredient...
Know-How—
...HAS MADE
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THE Leader!
WIRE FORMS
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In Industry, in homes, farms and shops, you'll find daily, living proof that D-&-B's KNOW-HOW pays out in EXTRA performance. Rely on expert engineers for parts that meet your exact needs and save you MONEY! Get Wire Forms, Springs and Stampings that are easily assembled . . . that withstand stress . . . and perform under the most trying conditions!
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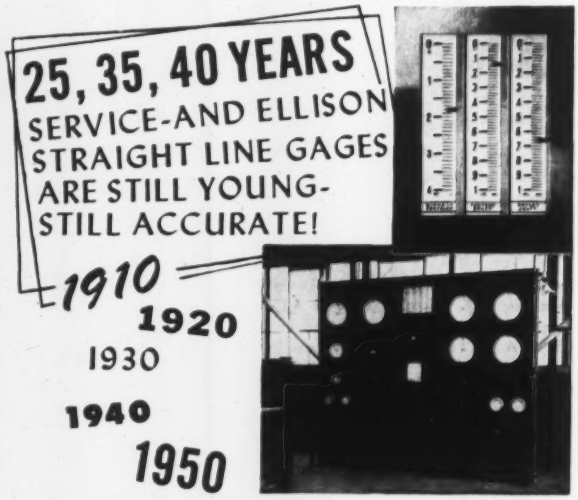

Reports from the field indicate that many of the first ELLISON Straight Line Draft Gages installed are still giving highly satisfactory performance. Ellison Gages give accurate readings—non-parallax pointers. Long lasting, positive, highly responsive mechanism. Bell type or Diafram type. Models for any panel board arrangement. Send for Bulletin 122—Bell type; Bulletin 124—Diafram type.

ELLISON DRAFT GAGE CO., INC.

552 W. MONROE ST. *Since 1896* CHICAGO 6, ILL.

The Ellison Line Also Includes:

Draft Gages, Bell and Diafram—Inclined Draft Gages—Portable Inclined Vertical Tube Gages—Vertical Tube Gages—Oil, Heavy Liquid and Mercury—Single and Multi-Tube-Saturator Gages—U Gages—Stationary and Portable—Air Filter Gages—Dial and Inclined Tube Types—Pitot Tubes—U Path Steam Calorimeters—Portable Gas Analyzers-Orsat-Type

KEEP INFORMED

NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Metering Pump

A low capacity, medium pressure unit designed for accurately proportioning various solutions or chemicals is described in a new bulletin issued by Proportioneers, Inc., division of B-I-F Industries, Inc., 345 Harris Ave., Providence, R. I.

Features of the pump are listed, together with descriptive data, capacity tables, cutaway-dimension drawings. The Model 1105 is available in six types covering a capacity range from 0.12 to 20 gph.

Weld Tube Mill Handbook

A 64-page, illustrated handbook entitled "Electric Resistance Weld Tube Mills" describing the use of modern tube mills in the manufacture of pipe and tube is available from Yoder Co., 5500 Walworth Ave., Cleveland, Ohio.

A step-by-step description of the electric-weld process beginning with the roll forming and shaping of tube, through to the finished product is provided. Photographs, drawings, and charts illustrate operation, capacities, and applications of electric-weld tube mills of various sizes.

Steel Tube Fittings

Publication of a 48-page steel tube fittings catalog is announced by Weatherhead Co., Fort Wayne Div., 128 W. Washington Blvd., Fort Wayne, Ind.

The catalog incorporates engineering data on hydraulic flareless tube fittings and SAE 37 deg Flare (JIC) hydraulic tube fittings. A section is devoted to assembly instructions, materials, finishes and operating pressures.

Stainless Steel Alloys

An eight-page data sheet on the chromium-nickel-manganese stainless steels types 202, 204, and 204L is being distributed by Allegheny Ludlum Steel Corp., 2020 Oliver Bldg., Pittsburgh 22, Pa.

The publication gives information on such items as intergranular corrosion, mechanical properties, analysis, and stress rupture properties. According to the company, the types 202, 204, and 204L represents a new family of austenitic stainless steels which possess very desirable mechanical and corrosion resisting properties. They correspond to the chromium-nickel types 302, 304, and 304L, but use substantially less nickel.

Miniature Gear Boxes

A revised four-page, two-color illustrated brochure, SW-1, describing the firm's latest developments, is now available from Southwestern Industries, Inc., 5880 Centinela Ave., Los Angeles, Calif.

The edition describes and illustrates miniaturized gear boxes, miniaturized vibration-resistant pressure switches, and lightweight, compact screwjack actuators. The company's equipment, research and development facilities and customer services are also discussed.

Heat Exchange Data

A four-page bulletin, HE-1, is available from Heat Transfer Co., 145 Sussex Rd., West Englewood, N. J.

The bulletin describes shell and tube heat exchange equipment. It points out the function of the company; the manufacture of "Custom Engineered" equipment. Construction features, general specifications and standard materials for the line of heat exchange equipment are outlined in tabular form.

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to give you better
SPRAY NOZZLES
• Shown above is a portion of Spraying Systems' own research facilities. Here the variables of nozzle design, fluid properties and operating conditions are studied and measured . . . to provide original data for better design and improved performance wherever spraying is involved.
WRITE FOR Catalog 24 . . . contains forty-eight pages of complete information on thousands of nozzle types and capacities.
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3265 RANDOLPH STREET • BELLWOOD, ILL.
ADVANCED SPRAY NOZZLE DESIGN FOR NEW DIMENSIONS IN CONTROL AND PERFORMANCE

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LESS MAINTENANCE, FEWER SHUTDOWNS for your compressor. (air, gas, ammonia)

• up to 40% more valve area • minimum pressure loss • higher efficiency • less power consumption • normal discharge temperature • quiet, vibration-free • utmost safety • lower operating costs

VOSS VALVES are made to specification, machined from solid stock (not cast) VALVES and PLATES are of heat-treated alloy or stainless steel; PLATES are machined, not stamped, and ground for precise close-tolerance fit; are dimensionally stable...ductile...resist fracture, high temperatures and corrosion...withstand fatigue. SPRINGS, of heavy rectangular sections and large diameters, add to dependability and safety.

Our detailed proposal will be sent without obligation. Send name, bore, stroke and speed of machine.

VOSS VALVES J. H. H. VOSS Co., Inc. 785 East 144th Street, New York 54, N. Y.

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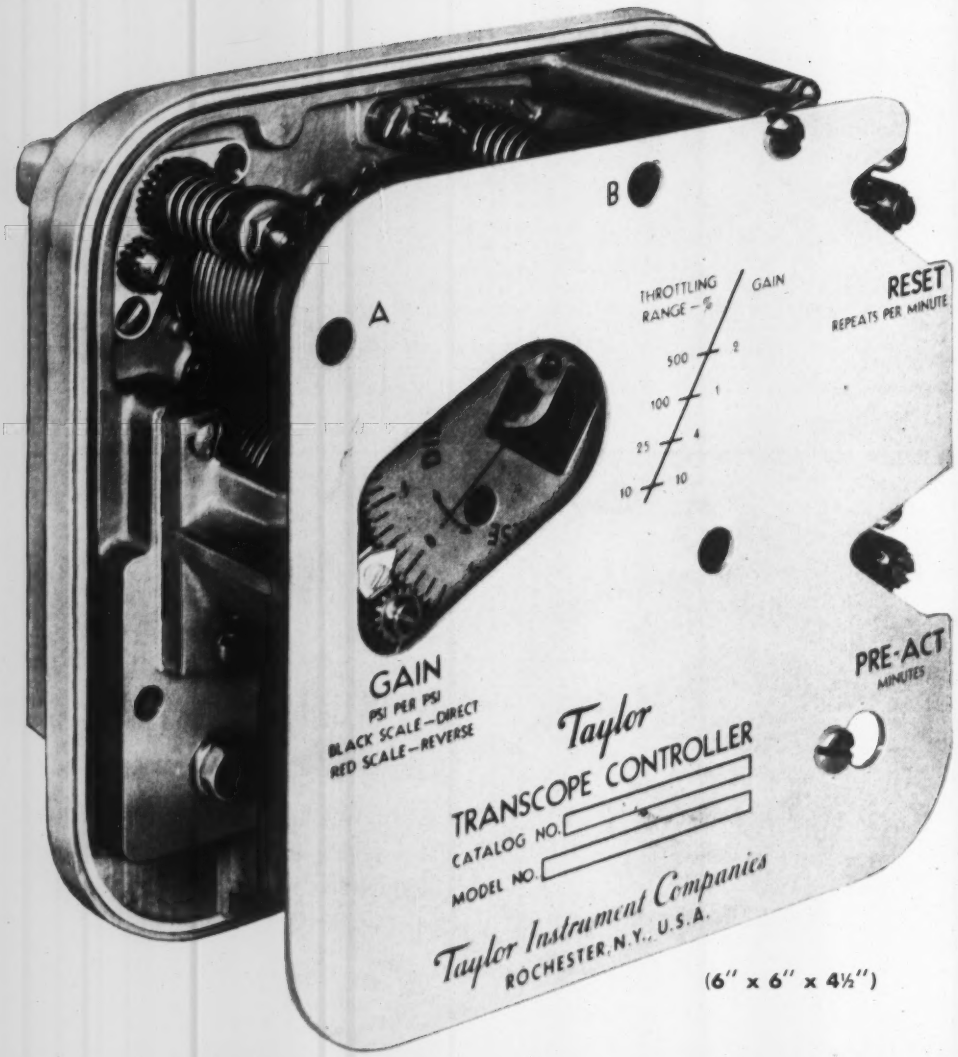
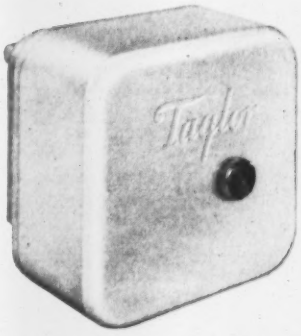


Taylor Instruments

SCOPE* Controller

Performance in a Small Package

Latest addition to famous Transet line uses unique Motion-Balance principle. Proven by months of tests on toughest applications.



HERE'S the first in a series of new Taylor TRANSCOPE instruments that will set new standards of process control performance. It's the new TRANSCOPE Controller—a miniature controller that's new in design, new in principle . . . and in performance has no equal, particularly on applications where the span of measurement is very short. It is ideal for the time constants of modern processing.

Simple to adjust, easy to maintain—and to convert from one form of control to another, the TRANSCOPE Controller can be panel, rack or field mounted. The adjustable proportional response system is based on the Motion-Balance principle that uses bellows as pressure sensitive elements. The illustration on the opposite page shows how the instrument looks —here's what it means in your plant:

1. Exceptionally fast and smooth response—particularly important on start-ups.

2. Ease of alignment—smooth-acting screw-driver adjustment because of ball-bearing construction.

3. New high standard of accuracy and setting for gain, reset and Pre-Act responses.

4. Outstanding in its insensitivity to ambient temperatures.

5. Very low air consumption—only 0.1 scfm.

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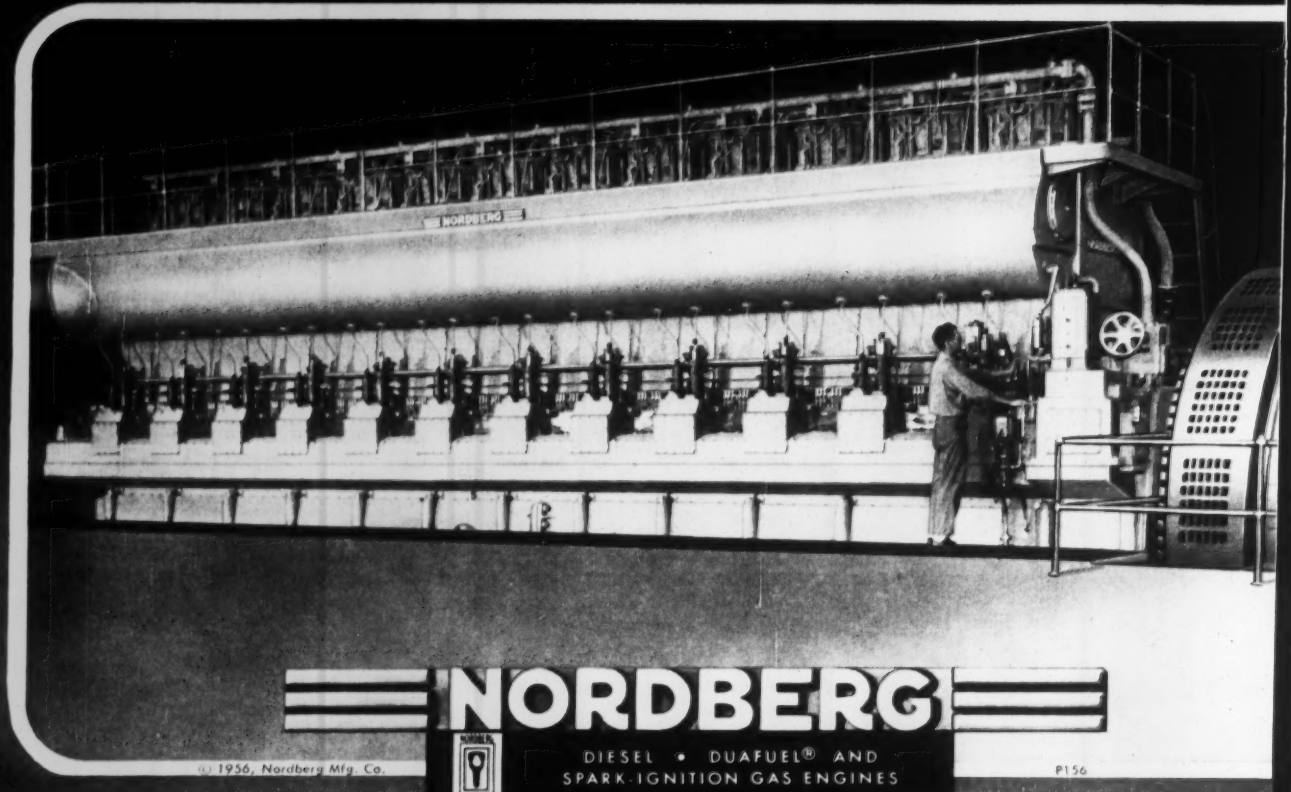

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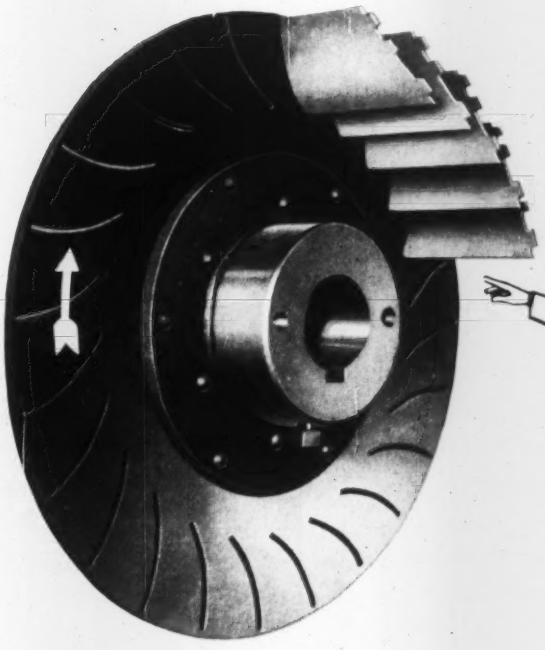

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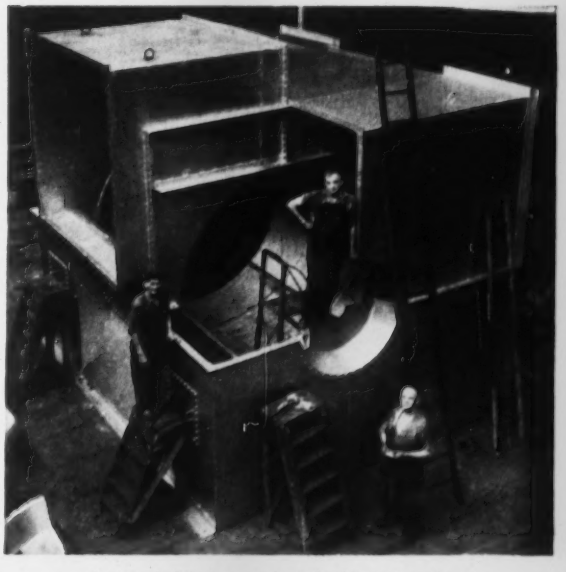

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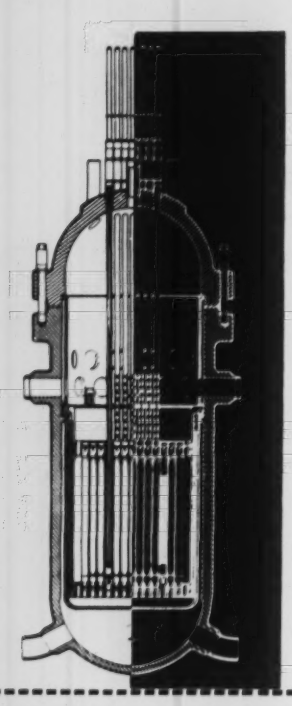

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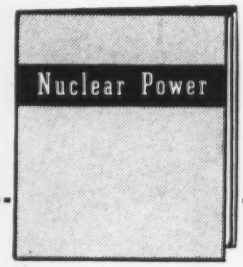

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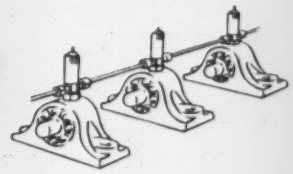

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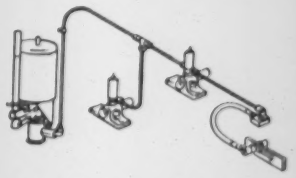

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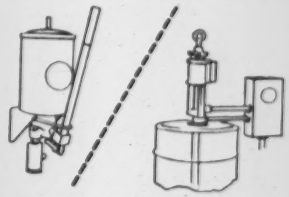

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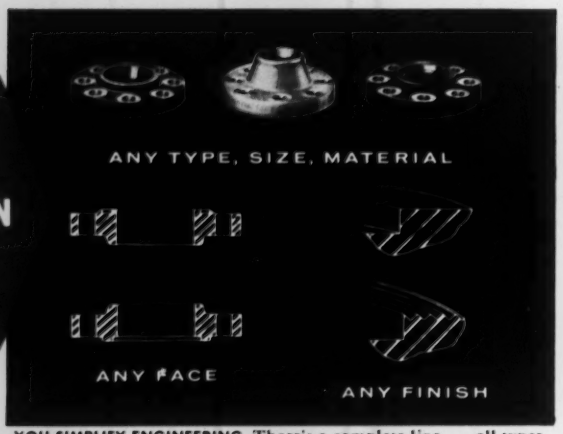

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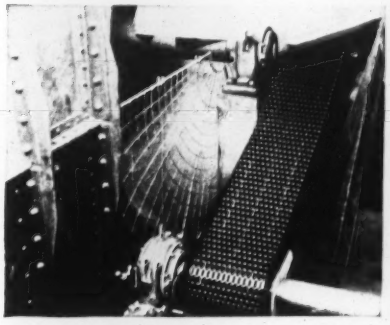

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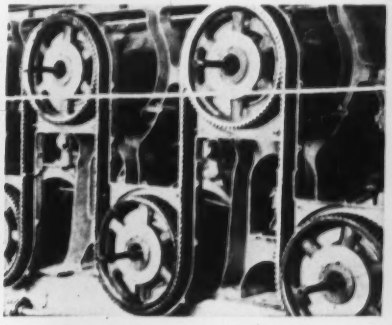

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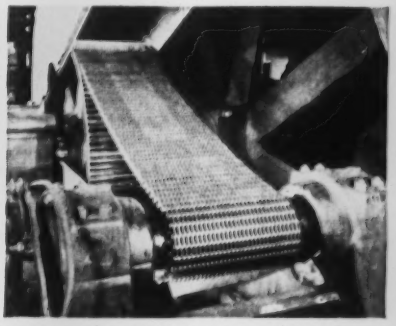

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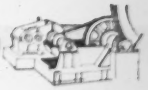
for materials handling power transmission  processing machinery

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Computer Logical Design Engineers determine the systems outline of a computer and its inter-connection with external equipment. Close liaison is maintained with mathematical support, circuit design, packaging and test engineers. Computer speed, memory size, configuration and arithmetic structure are tailored to requirements of weapons systems. *Do you belong on this team?*

Systems Evaluation Engineers test and evaluate electronic analog and transistorized digital computer systems design for aircraft; evaluate new systems and improvements to insure compliance with specifications and Air Force requirements. Other assignments: tie-in testing of peripheral equipment, liaison with design, development and field engineering. *Do you belong on this team?*

Harry Branning (center): B.S.E.E. 1950, Syracuse. Design Engineer in circuit design, 1951; October, 1954, promoted to Associate Engineer; April, 1956, promoted to Staff Engineer, Systems Planning. In June, 1956, appointed Project Engineer and Manager of the 110 Computer Circuit Design Department; discussing the performance and packaging details of a transistorized read amplifier.

William Dunn (standing): M.E. 1950, M.S.E.E. 1952, Stevens Institute. Technical Engineer, 1955; April, 1956, promoted to Associate Engineer; August, 1956, transferred to Development Engineering in charge of Logical Design for digital computers in advanced weapons systems; here discussing Boolean Algebra method of optimizing the logical design of an airborne digital computer.

Eli Wood (left): B.S.E.E. 1950, Connecticut. IBM Customer Engineer, July, 1950; September, 1952, transferred to ACL Field Engineering. February, 1954, in charge of Field Engineering at Hunter AFB; May, 1955, Associate Engineer; appointed Project Engineer, Manager of Systems Evaluation in August, 1956; here investigating a problem in radar data presentation set evaluation testing.

The brief records of the men cited above indicate only a few of the exciting activities right now in IBM Military Products. This division, organized 18 months ago, has grown enormously. A small-company atmosphere prevails. Men work in small teams . . . individual contributions are instantly recognized. Promotions occur frequently.

As a member of IBM Military Products, you'll enjoy physical surroundings and equipment second to none. Educational programs at IBM expense lead to advanced degrees. Salaries and benefits are excellent. Stability is guaranteed by IBM's history of consistent achievement—underlined by the fact that the rate of turnover at IBM is only one-sixth the national average.

Throughout the length and breadth of the United States IBM has built modern plants and laboratories. This map points out the various locations where you might live as an IBM em-

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TIME EQUIPMENT
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IBM MILITARY PRODUCTS

IBM Military Products?

Systems Engineers oversee the engineering support provided by the Systems Coordination and Specification Group to the factory on the AN/ASB-4 Bombing-Navigational System. Air Force requirements are analyzed and the resulting engineering changes evaluated to determine effect on system performance and accuracy. Mathematical error analyses are run. *Do you belong on this team?*

Systems Analysts anticipate performance and recommend design criteria before and during development of equipment. Later, they compare dynamic performance accuracy and reliability characteristics with what has been anticipated. Other assignments include Digital Computer Systems Engineering, Input-Output and Analog-Digital Conversion Engineering. *Do you belong on this team?*

Quentin Marble (left): B.S.M.E. 1951, Syracuse. Joined IBM in 1951; promoted to Design Engineer in 1952; May, 1955, promoted to Associate Engineer, and then to Project Engineer, Manager of the Systems Coordination and Specification Group, Production Engineering Department, in February, 1956; shown here describing a unique cooling design to a new employee in his group.

Monroe Dickinson (left): B.S.E.E. 1952, W.P.I.; M.S.E.E. 1954, M.I.T. Technical Engineer in analog and alternate computer techniques for weapons systems, 1952; Associate Engineer responsible for systems design and analysis, 1954; December, 1955, Staff Engineer, responsible for research planning; here reviewing set-up on laboratory analog computer of a sampled data control problem.

Exceptional career opportunities are now open in IBM Military Products for E.E.'s, M.E.'s, physicists, and mathematicians, in the following fields:

SYSTEMS PLANNING AND ANALYSIS
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PROGRAMMING
FIELD ENGINEERING
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COMPONENTS
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MATHEMATICS
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ployee. IBM Military Products include the Airborne Computer Laboratories located in Owego, N. Y., and the Project SAGE installations directed from Kingston, New York.

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International Business Machines Corp.
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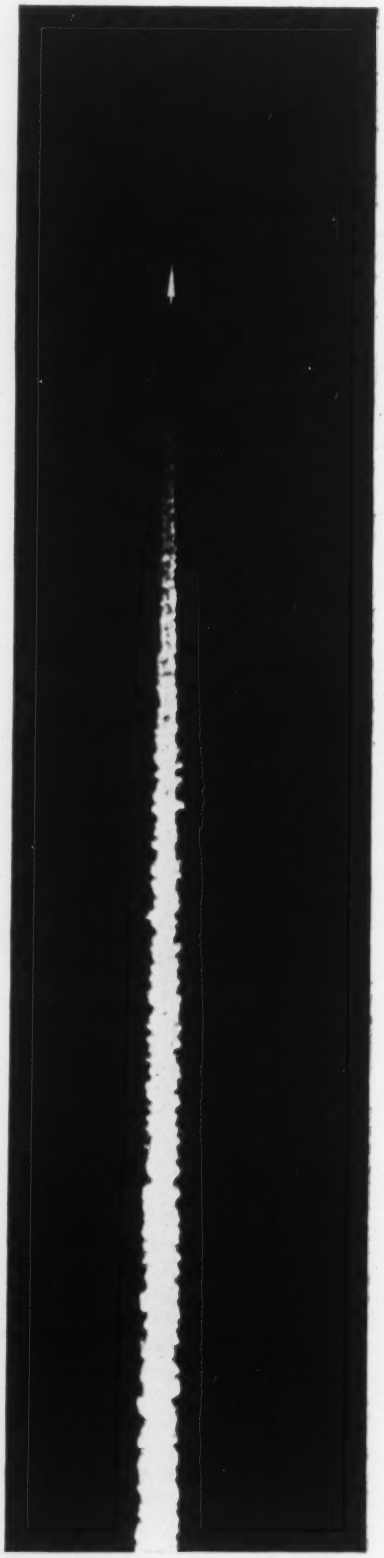
CHUCK PRICE earned a BS in 1944, MS in 1947, and a PHD in Mathematics in 1950—all from the University of Chicago. In 1953 he joined North American's Advanced Design Department. Since then he has earned three promotions and is now a Group Leader supervising 36 engineers working on new aircraft design. His Group's objective—to select the aircraft configuration best suited to perform a specific mission.

MIT graduate **HAROLD RAIKLEN** received his BS in Mechanical Engineering in 1947—his MS two years later. His first North American assignment was to analyze and test dynamic stability and response of powered flight controls. Today, less than four years after joining the Company, Hal heads a section devoted to design and study of mechanized components, including flight control systems—his third supervisory position.



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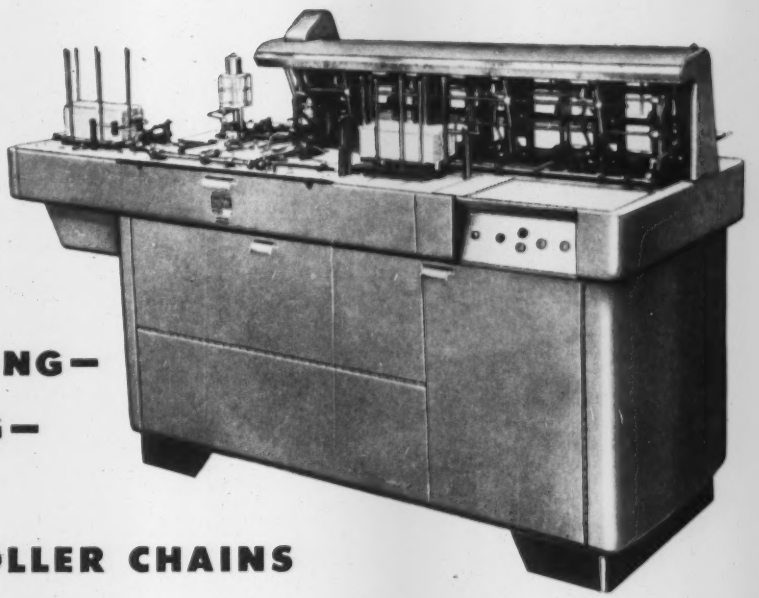

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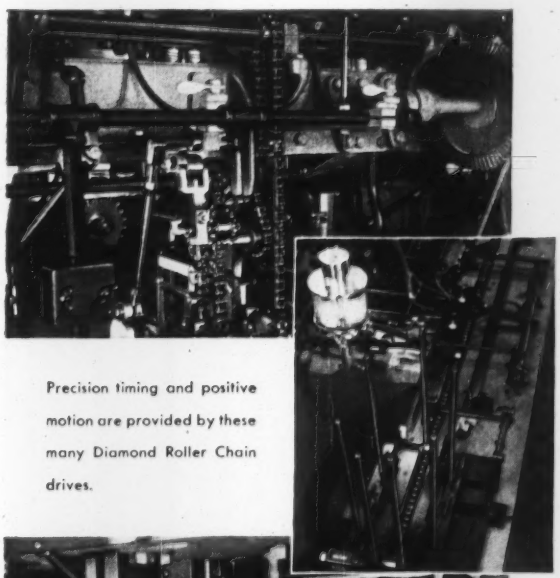

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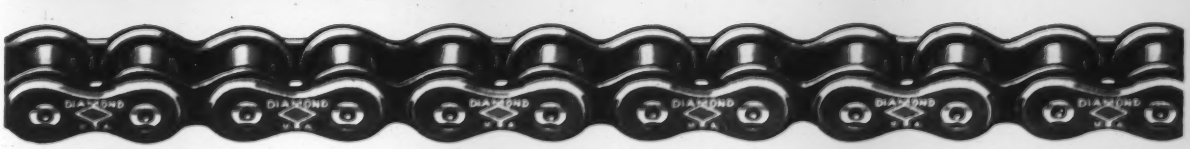
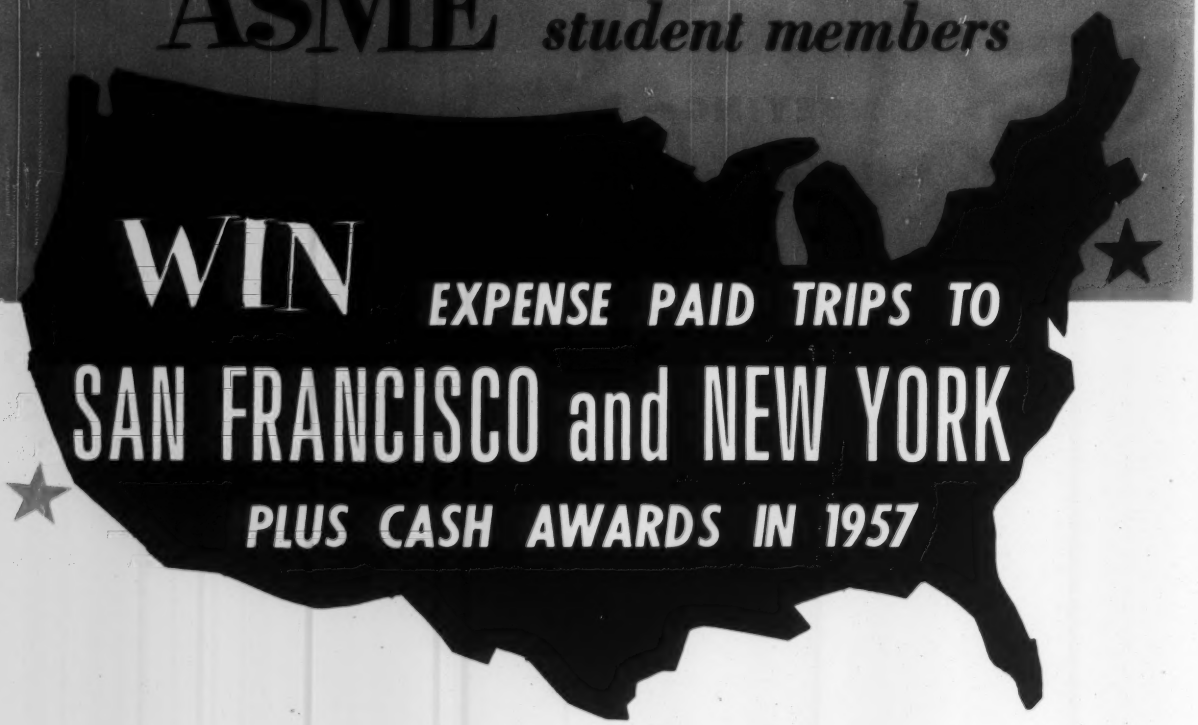


attention...

ASME *student members*



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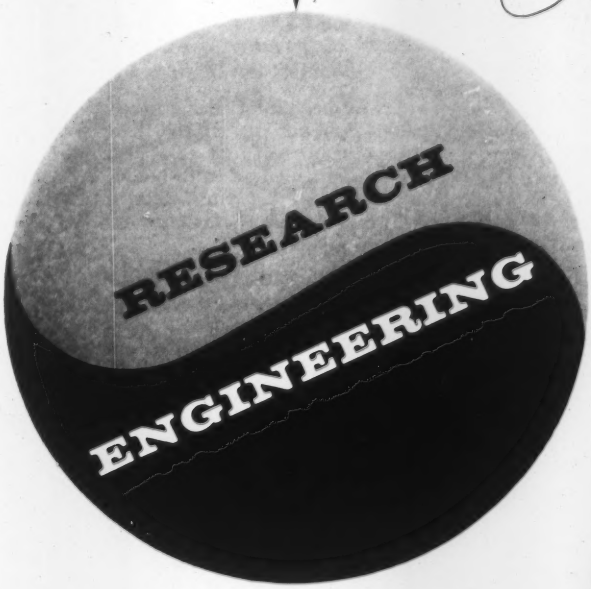

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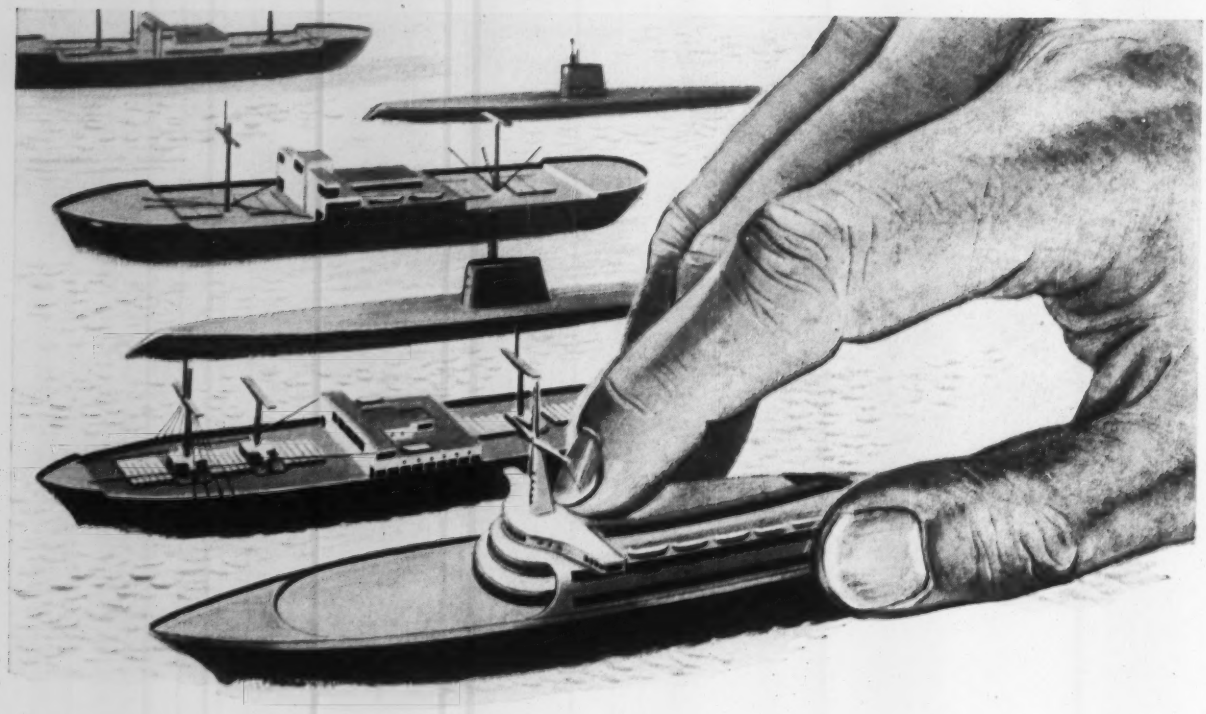

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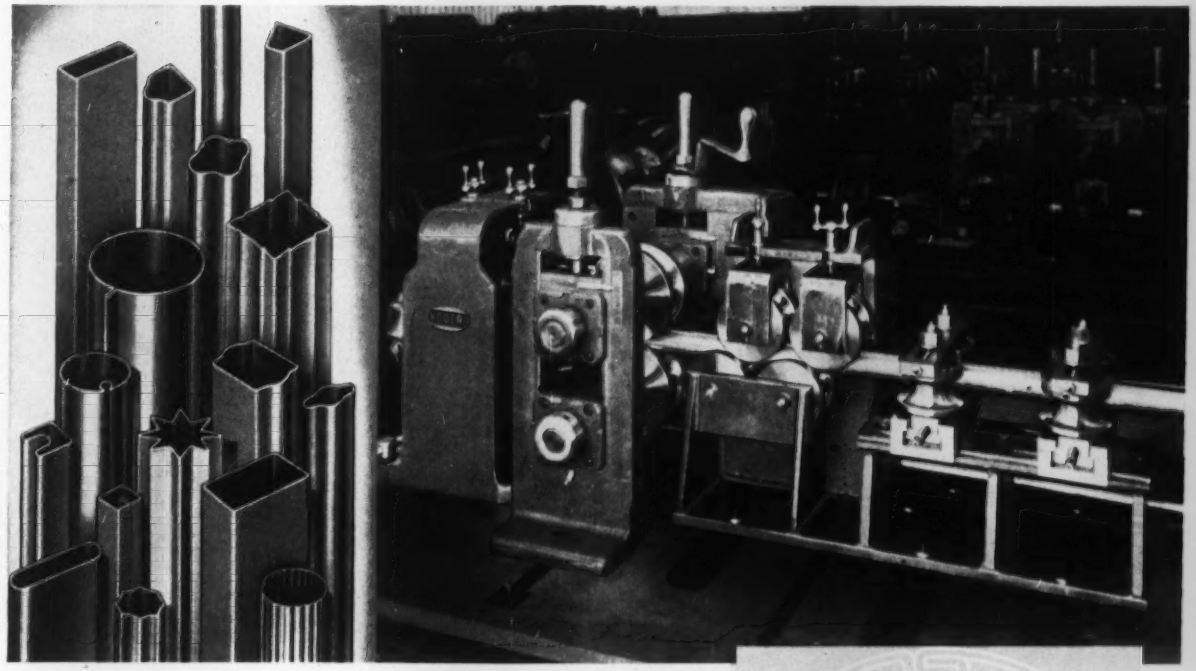

Lock-Seaming attachment at exit end of forming machine.

COLD ROLL FORMING TUBULAR SHAPES

Among the wide variety of things you can make on a Yoder Cold Roll Forming machine are round, square, oval, rectangular and other tubular shapes, such as illustrated at left above. The seams may be open, lapped, butted, dovetailed, interlocking, etc.—as indicated in Figures 1 to 6 at the right.

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To meet that tough specification for evaporator coils and high temperature coils, B&W supplies Electric-Resistance-Welded Tubing with precision-made serrations on the I.D. Rockwell hardness must be held within close tolerances, and the seam-weld must withstand 1,000 pounds pressure—no interior surface copper is permitted.

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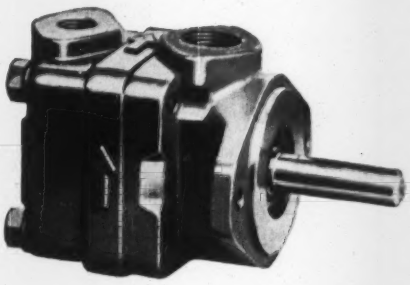
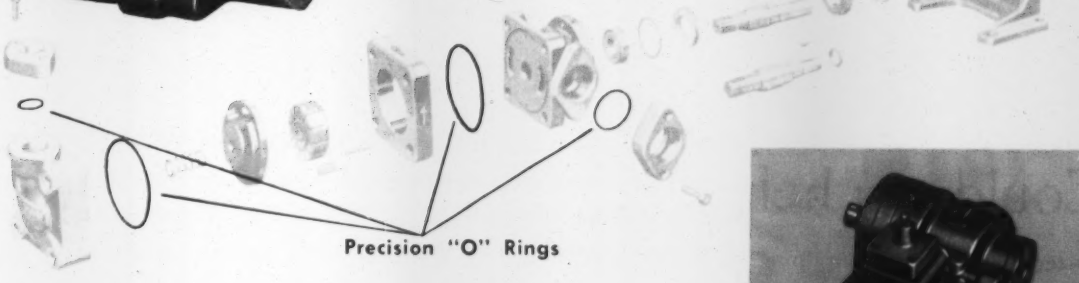
Precision "O" Rings protect the Heart of Hydraulic Power Steering Systems.



Precision "O" Rings provide positive hydraulic oil seal in this 1500 P.S.I. Mobile pump in a temperature range up to 160°F. Quality control in "O" Ring manufacture protects this heart of a power steering system.



Precision "O" Rings

There can be no compromise on quality and reliability in hydraulic power steering pumps. VICKERS Incorporated, of Detroit, Mich., the world's largest manufacturer of fine hydraulic pumps, use Precision "O" Rings to assure dependable, long life performance under exacting conditions.

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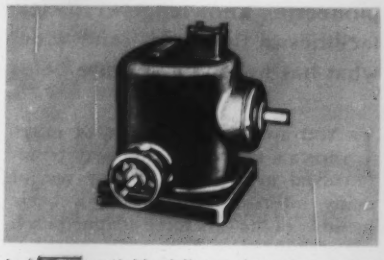

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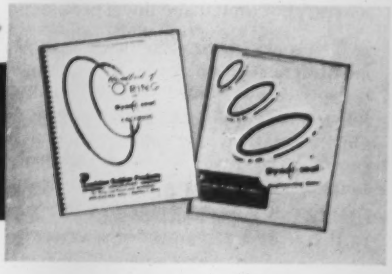

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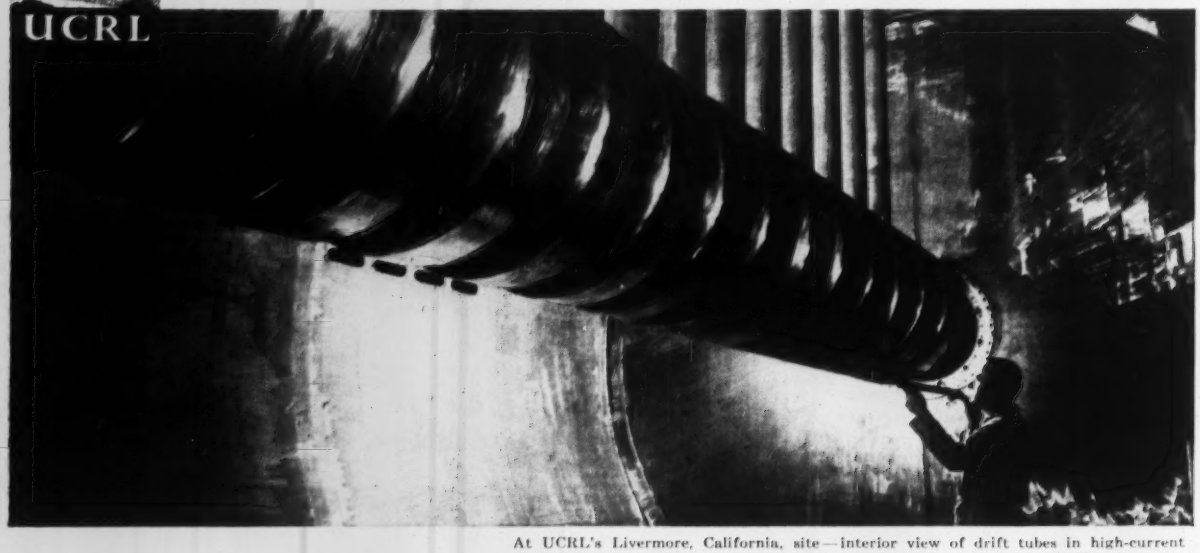

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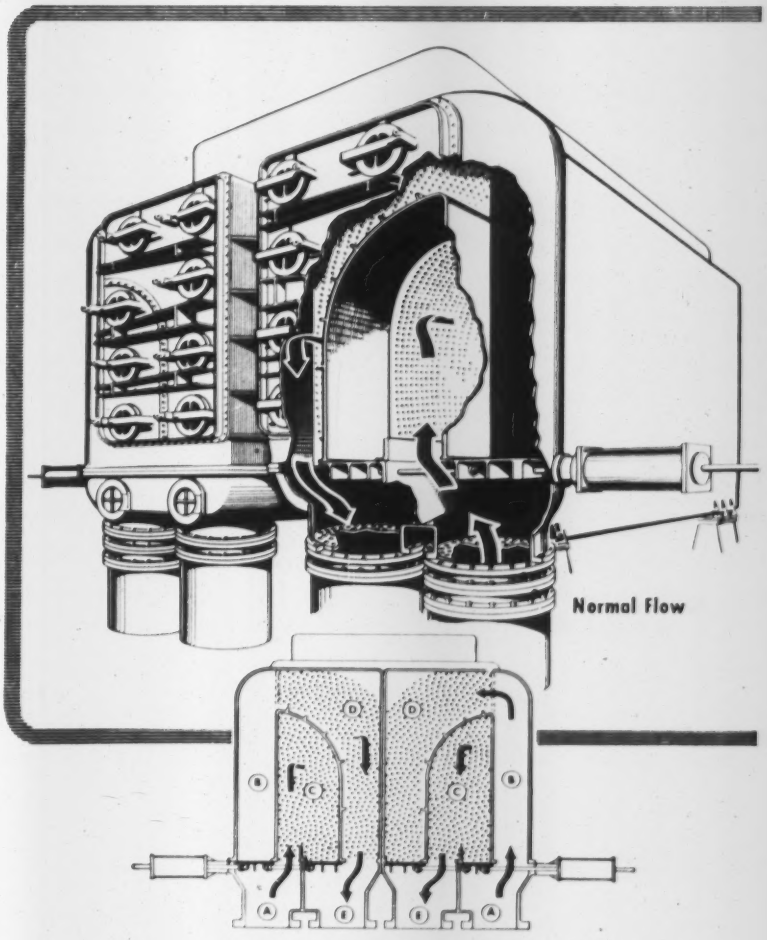

HOW "REVERSE FLOW" WORKS

Left Side Shows Normal Operation

Water enters inlet A with right port open. Flows through tube bank C to rear of condenser . . . returns through tube bank D to front of condenser and discharges at E.

Right Side Shows Reverse Flow

Sluice gates move on a common stem. Water flows up through channel B, and through tube bank D to rear of condenser . . . returns through tube bank C to front of condenser.

In the C. H. Wheeler Divided Water Box Design, each half of the condenser can be back-flushed independently.

V-(603

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. . . basic tool of the G-R sound-measuring line . . . reads directly sound-pressure levels from 24 db to 140 db above standard A.S.A. reference level, and to 190 db with accessory high-level microphones . . . built-in weighting networks approximate the ear's response at various levels . . . internal calibration system permits convenient, rapid standardization . . . instrument is light in weight, dependable, compact, and completely self-contained.

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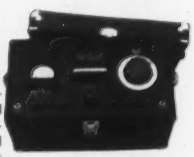
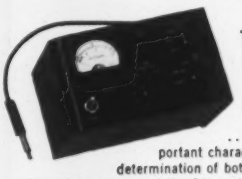
. . . for rapid, accurate broad-band analyses of sound energies widely distributed over the audio spectrum, as produced by shock excitation or turbulence . . . eight bands cover the frequency range from 20 to 10,000 cycles; each filter has excellent selectivity characteristics.



Type 760-B Sound Analyzer, $520

. . . for narrow-band measurements . . . best suited for analyzing noises of rotating, reciprocating, and other cyclic mechanisms where prevalent frequency components are harmonically related . . . direct reading over 25- to 7500-cycle range . . . bandwidth is 2% of selected frequency . . . instrument frequency response is flat within ±2 db over entire range.



Type 1558-A Impact-Noise Analyzer, $210

. . . measures three important characteristics, permitting determination of both level and duration of transients characteristic of impact noises . . . compact, portable instrument is first expressly designed for direct-reading measurements of impact noise.

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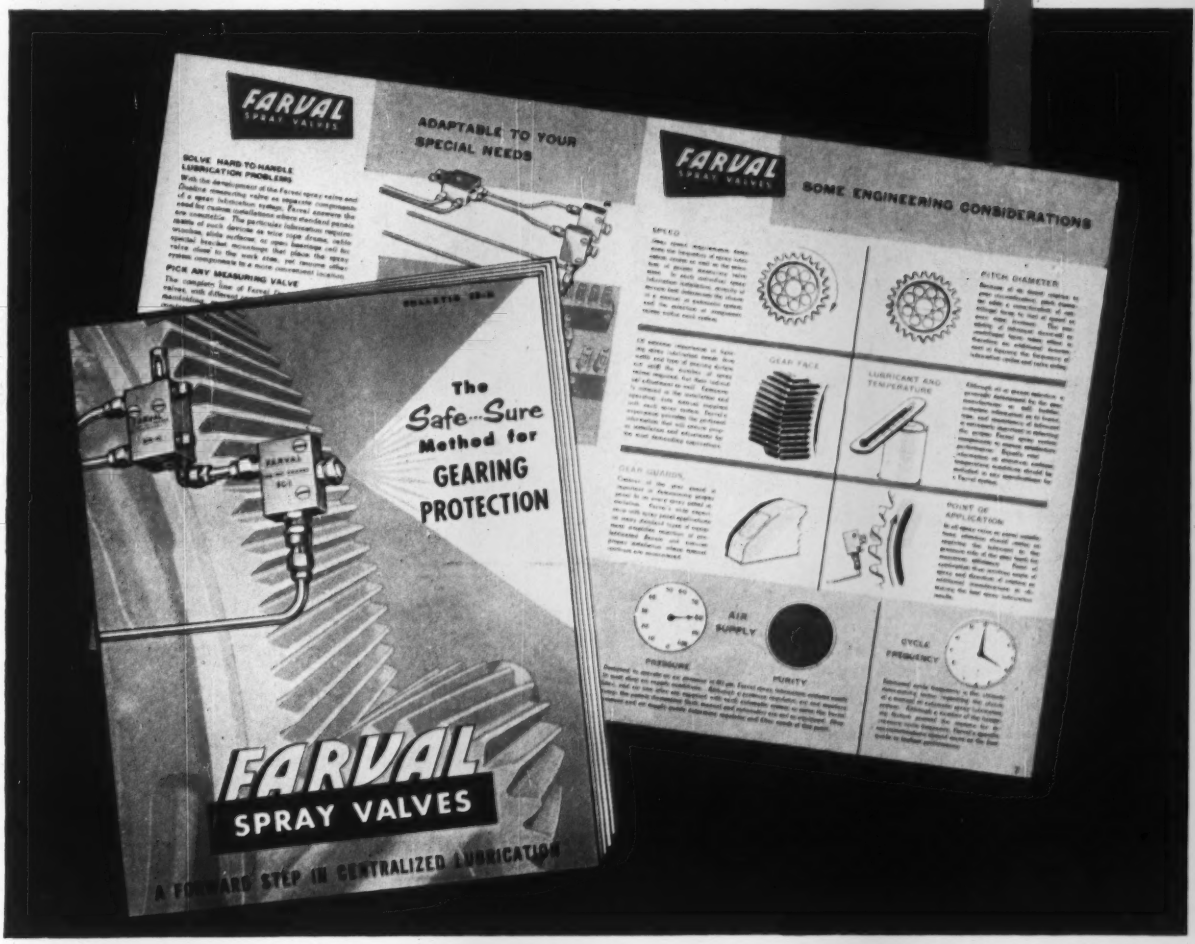

● If you design, build or use equipment with large gears, you will want Bulletin 60-A. Its 8 pages provide full information on Farval Spray Lubrication Systems available for manual or automatic operation.

Farval Spray Valves are completely flexible. They can be used alone, in panel set-ups mounted on gear housings, or as part of a Farval Dualine System—wherever compressed air is available. As with standard Dualine valves, the spray can be operated as often as needed to deliver any amount of oil or grease—on gears, slide surfaces or other areas needing lubrication.

Thousands of Farval Spray Valves are used in many industries. You, too, should enjoy their benefits. Write today. You will receive a copy of Bulletin 60-A and the name of the Farval representative in your area who can help you select the proper equipment for your machines. The Farval Corporation, 3264 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.

Proved in 30 years of service, Farval manual and automatic centralized lubrication systems protect millions of industrial bearings. Wherever you see the familiar Dualine valve manifolds, dual lubricant lines and central pumping station, you know a machine is being properly lubricated.

nuclear weapons development

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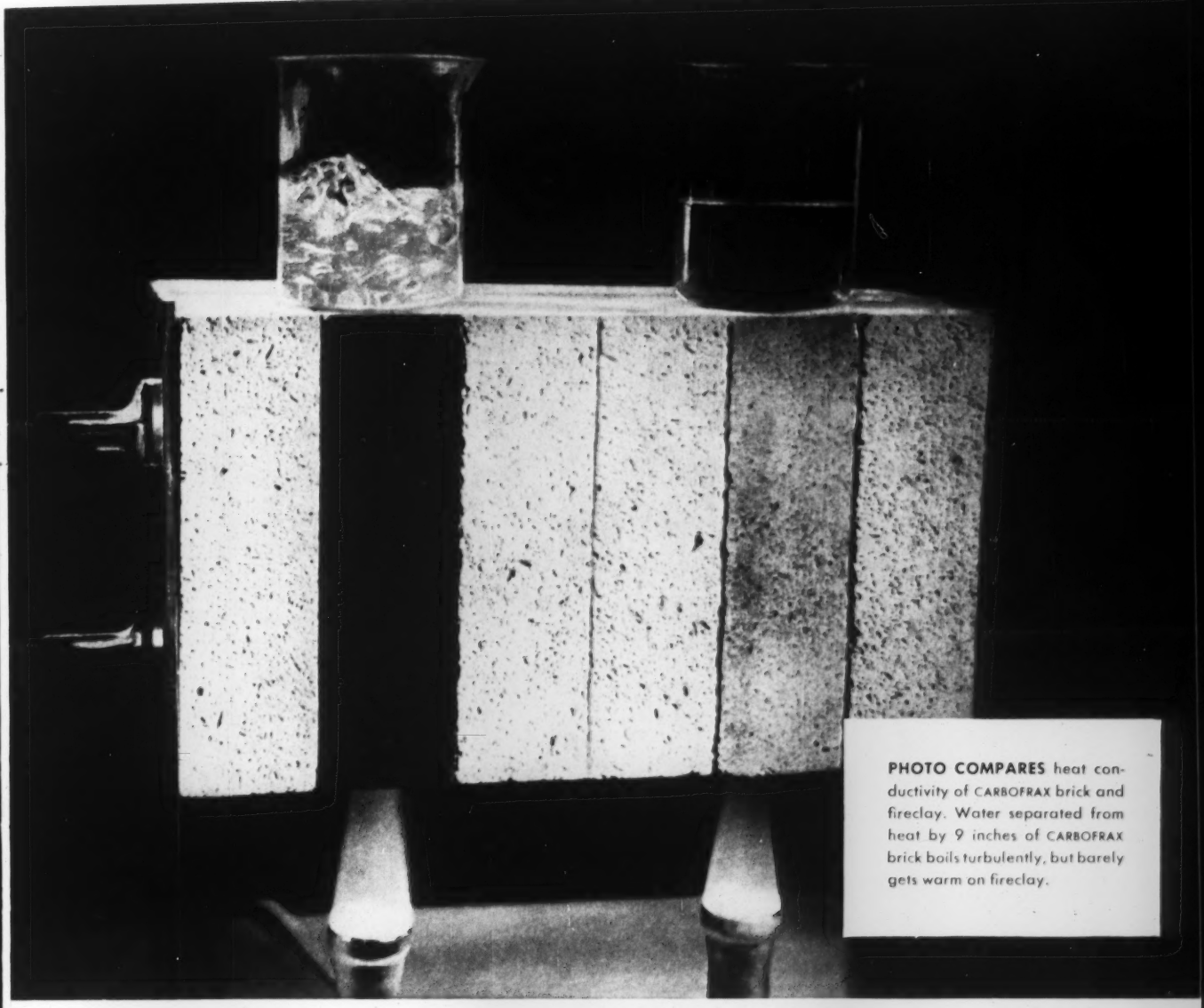

PHOTO COMPARES heat conductivity of CARBOFRAX brick and fireclay. Water separated from heat by 9 inches of CARBOFRAX brick boils turbulently, but barely gets warm on fireclay.

Refractories – for high heat conductivity

High heat conductivity—roughly 11 times that of fireclay and about 70% that of chrome-nickel steels—is one of the properties of CARBOFRAX® silicon carbide refractories. It is an ideal material for muffles, radiant tubes, retorts and similar structures where you need exceptional resistance to direct flame plus the ability to conduct heat efficiently. At 2200°F, thermal conductivity of CARBOFRAX brick is 109BTU/hr., sq. ft. and °F/in. of thickness.

CARBOFRAX refractories typify the many super refractories pioneered by Carborundum. Each has a wide range of properties. One, for example, is formed into precision parts that look like cast iron yet resist over 3000°F. Another, a new ceramic fiber, filters and insulates at temperatures no existing mineral or glass fiber can take.

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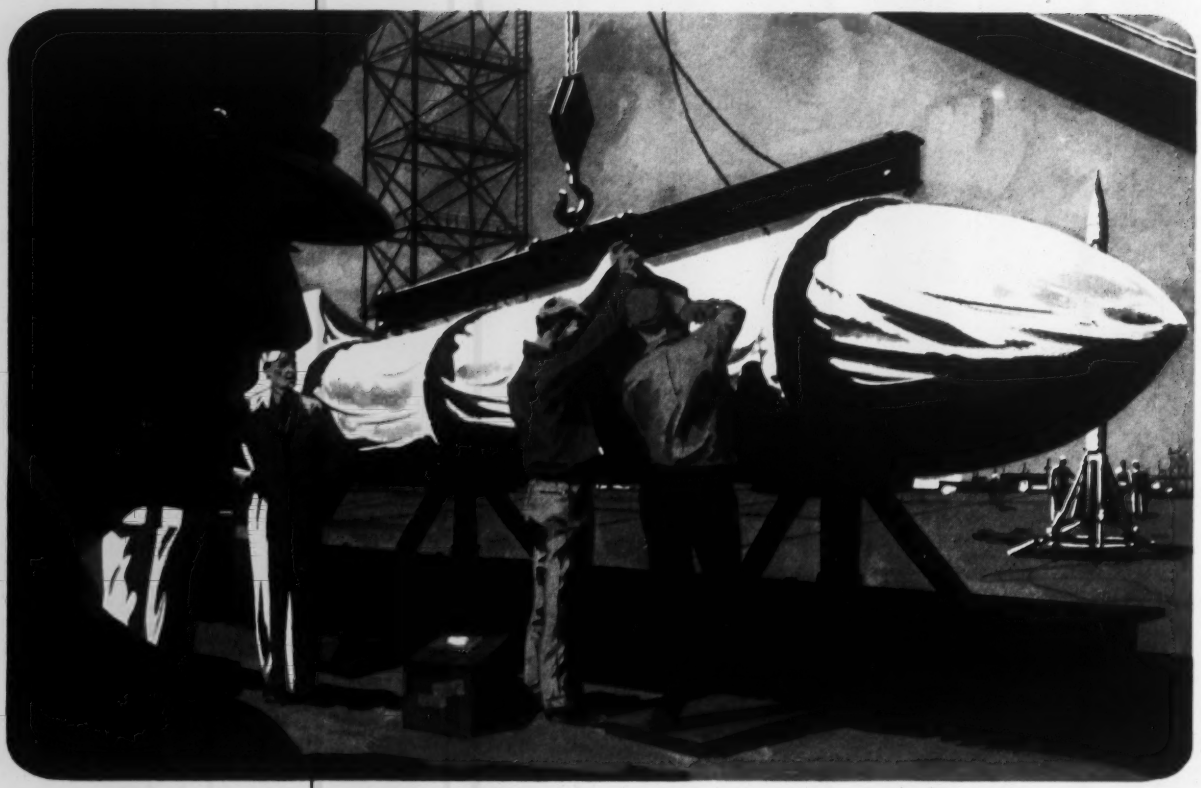
IMPORTANT ACHIEVEMENTS AT JPL



Development of the Sergeant

The Jet Propulsion Laboratory is a stable research and development center located north of Pasadena in the foothills of the San Gabriel mountains. Covering an 80 acre area and employing 1600 people, it is close to attractive residential areas.

The Laboratory is staffed by the California Institute of Technology and develops its many projects in basic research under contract with the U.S. Government.

Opportunities open to qualified engineers of U.S. citizenship. Inquiries now invited.

Announced as a successor to the Corporal is another highly accurate surface-to-surface ballistic missile named "The Sergeant." This weapon will continue the United States Army's advance in the development of mobile firepower.

The latest techniques in guidance, airframe design and rocket propulsion are being applied to the development of this rugged weapon which is capable of operating in any area.

The Jet Propulsion Laboratory, designer of this new missile, has the same prime technical responsibility to provide the development of the complete Sergeant system as it had for the Corporal weapon system.

In addition to weapon development the "Lab" carries on supporting research in all areas related to guided missile work. These supporting research and weapon development activities complement and extend each other to produce superior end results.

This fact, coupled with ideal facilities and working conditions at JPL, is a prime attraction for scientists and engineers of unusual ability because of their close integration with such vital programs. At the same time, other varied and interesting activities in weapon development are providing new challenges and openings for qualified people.

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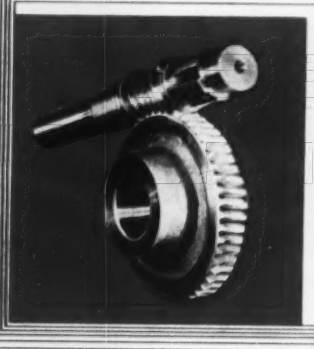
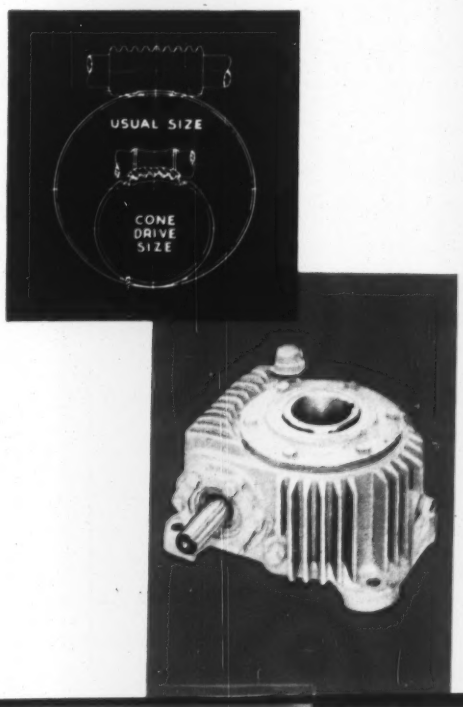
for concentrated power





. . . CONE-DRIVE gearing has no equal.

You can pass an amazing amount of power through a set of Cone-Drive gears.

Want to cut product size? Cone-Drive will give you a more compact gear train with reserve load capacity.

Want to boost power output and hold size? That's easy with Cone-Drive gears. They'll carry two, three, and four times the load of cylindrical worm gearing.

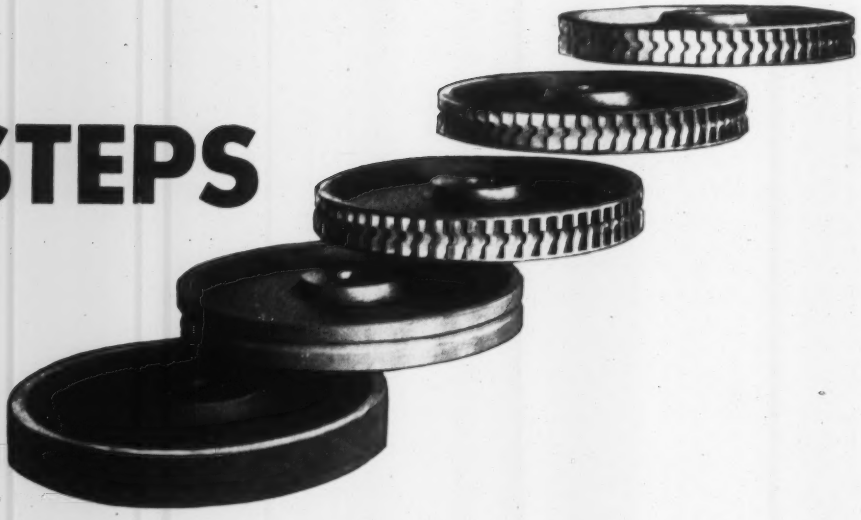
Why? In Cone-Drive gears, the load isn't concentrated on a small area per tooth or on just one or two teeth at a time. Cone-Drive's exclusive double-enveloping principle distributes the load over a lot of teeth and over more area on each tooth.

It cuts the unit loading the same way a pair of snowshoes supports a heavy man.

Ask for Bulletin CD-400 for complete details.

CONE-DRIVE GEARS
Division Michigan Tool Company
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNichols Road • Detroit 12, Michigan

5 STEPS



in making an almost indestructible turbine

The rotor of a Terry solid-wheel turbine is a single forging of special composition steel. It is first rough turned in two operations, as shown, and then two cuts are taken to mill the semi-circular buckets from the solid metal. The wheel at the top has been finished, ready for mounting on the shaft. *The result is a single-piece wheel with no parts to loosen or wear out.*

Blade wear, which might occur after many years of usage, is not important, because the power-producing action of the steam takes place on the curved surfaces at the backs of the buckets. Thus wear does not materially affect horsepower or efficiency.

The blades can't foul. They have a one-inch clearance, and are further protected by the projecting rims at the sides of the wheel.

The Terry solid-wheel turbine is an extremely reliable piece of equipment. Write for details—today. Ask for a copy of bulletin S-116.

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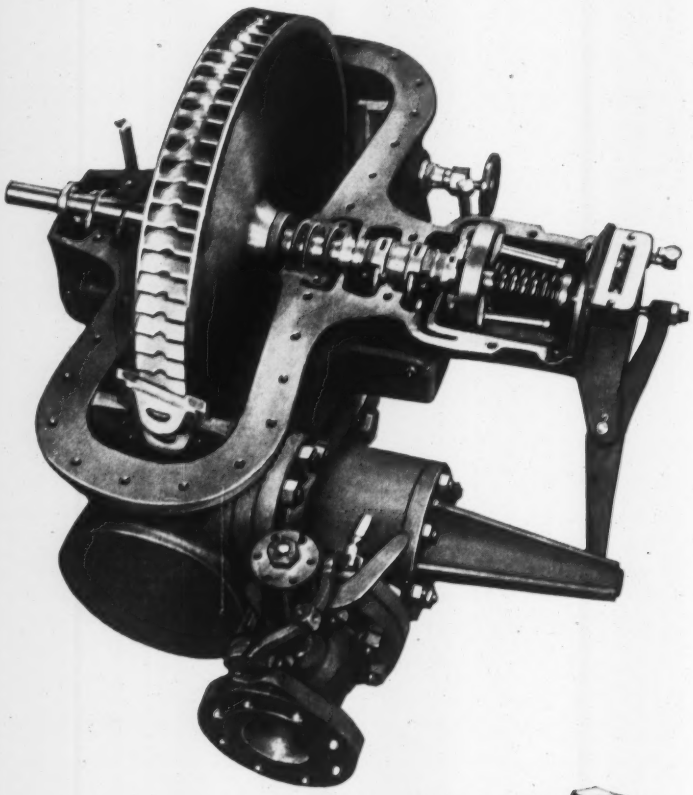
TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TT-1204



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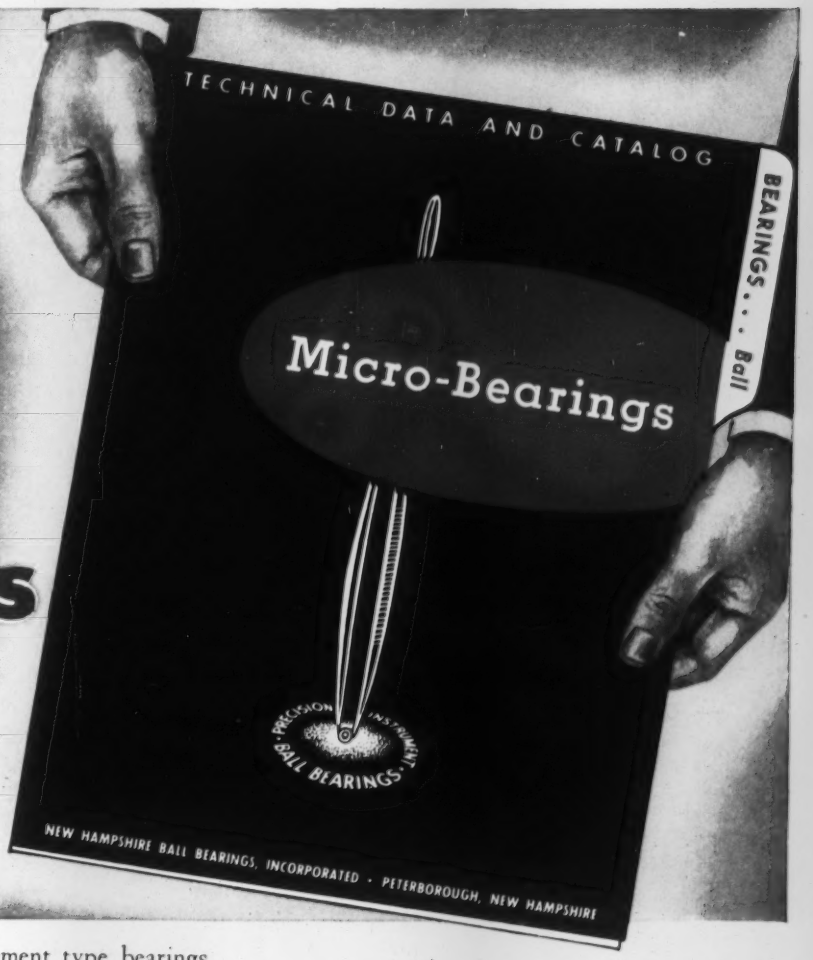
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If you work with small instrument type bearings you'll find this new, authoritative publication an extremely valuable and handy source of engineering data arranged in convenient form for practical reference.

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Materials	*Lubrication*
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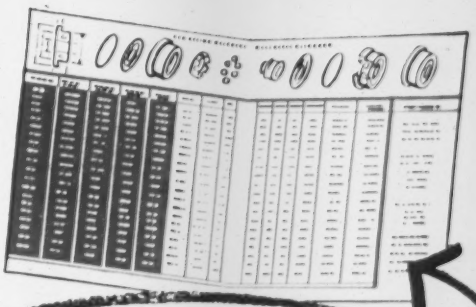

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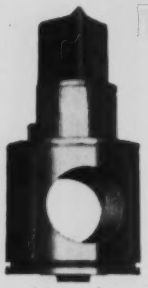

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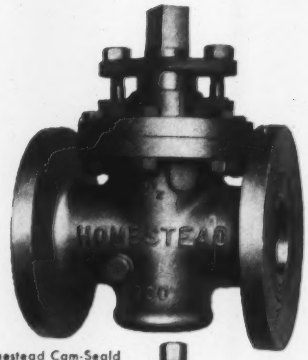
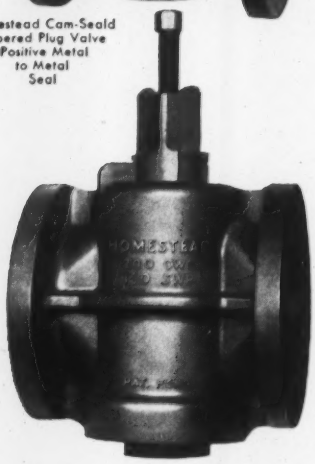


Homestead Cam-Seald Tapered Plug Valve Positive Metal to Metal Seal



Homestead Lubricated Plug Valve High Pressure Chemical Seal

Name the type of valve you need in the metal or alloy you require with the port opening you want—and we can furnish it. Or if you have a valve problem that defies solution, write us, naming the fluid, concentration, temperature, pressure, valve size, function and frequency of operation. We will be happy to recommend the best and most economical valve for your service conditions.

For complete information on Homestead Plug Valves

Homestead Lever-Seald Tapered Plug Valve Positive Seal Without Lubrication

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Please send me information on the following Homestead Plug Valves:

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Is your tubing bottleneck shown here?

Bundy Engineers and versatile Bundyweld Tubing can beat the knottiest tubing design problem!

If you think it can't be done with tubing, it's a challenge to Bundy. For years, Bundy Engineers have specialized in working with customers and prospects, solving the insolvable. A unique combination of imagination and experience, plus the extreme versatility of Bundyweld Steel Tubing, has paid off again and again.

Check first with Bundy for workable solutions to your tubing design problems. Whether you are in the design, developmental, or application stage of your product, Bundy will be glad to work with you. Hundreds of manufacturers have used this Bundy service to advantage.

Bundyweld Tubing offers an unusual combination of properties: high thermal conductivity; high bursting strength; ease of fabrication; and thinner-walled, yet stronger composition. It is the safety standard of the refrigeration industry, and is used in 95% of today's cars, in an average of 20 applications each.

Call, write, or wire us today!

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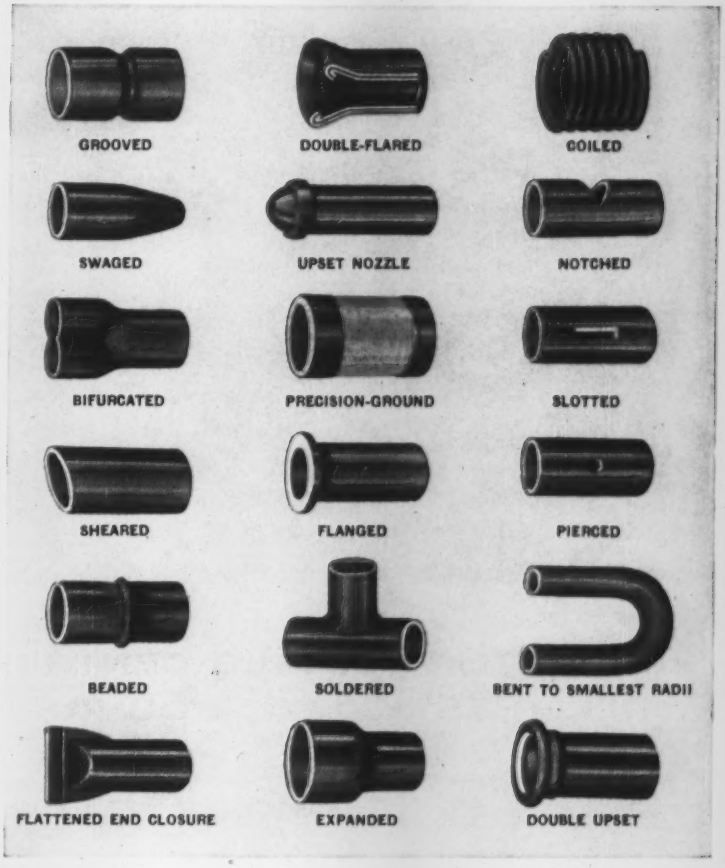


Shown above are but a few of the fabrication operations which are possible with Bundyweld Steel Tubing. Many of these, and others not shown, were developed through solving a specific problem brought to us by a customer or prospect. Bundy invites you to avail yourself of this design service.

WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING. AFFILIATED PLANTS IN AUSTRALIA, ENGLAND, FRANCE, ITALY, AND GERMANY

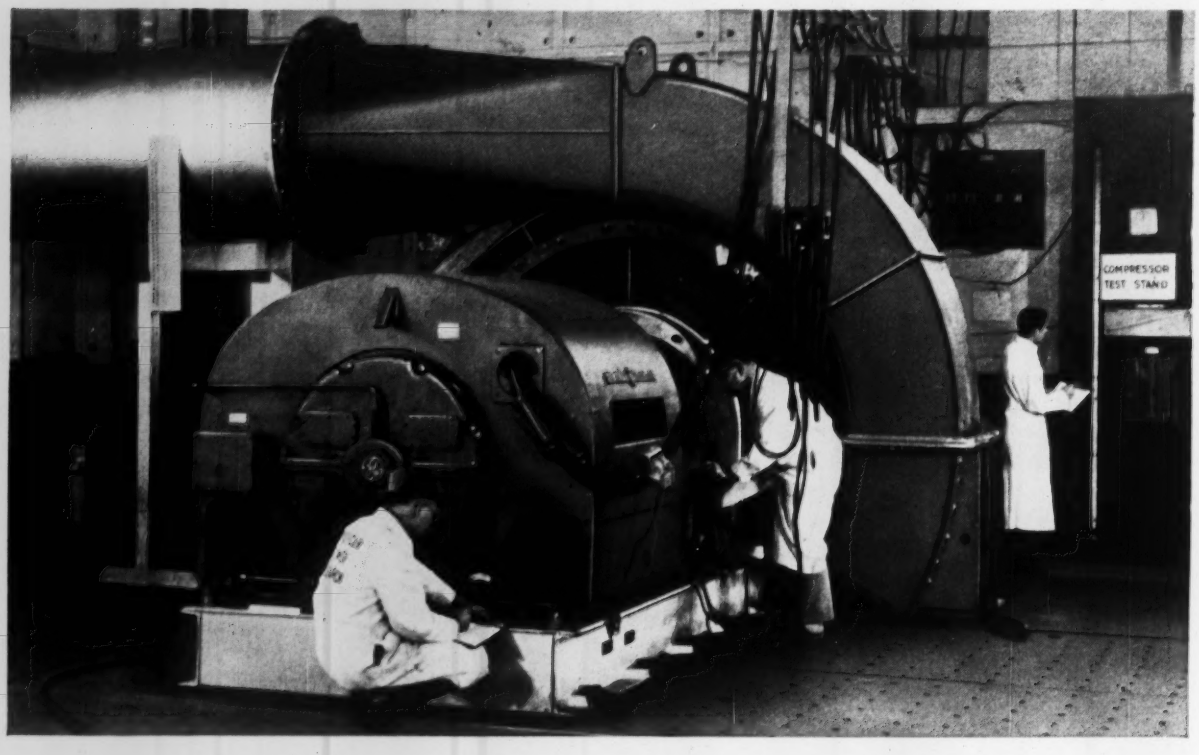
Bundyweld starts as a single strip of copper-coated steel. Then it's
. . . continuously rolled twice around laterally into a tube of uniform thickness and passed
through a furnace. Copper coating fuses with steel. Result . . .
SIZES UP 10% O.D.
Bundyweld, double-walled and brazed through 360° of wall contact.

NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

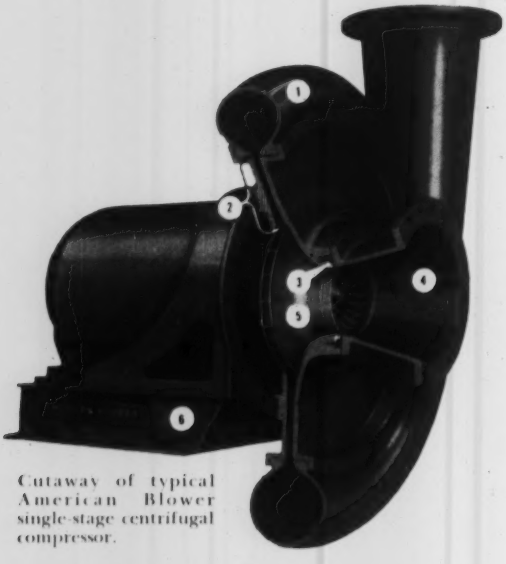
BUNDYWELD TUBING®

DOUBLE-WALLED FROM A SINGLE STRIP

HERE'S THE LATEST AIR-HANDLING EQUIPMENT FROM AMERICAN BLOWER



LABORATORY TESTED CENTRIFUGAL COMPRESSOR DELIVERS 330,805 POUNDS OF AIR PER HOUR!



Cutaway of typical American Blower single-stage centrifugal compressor.

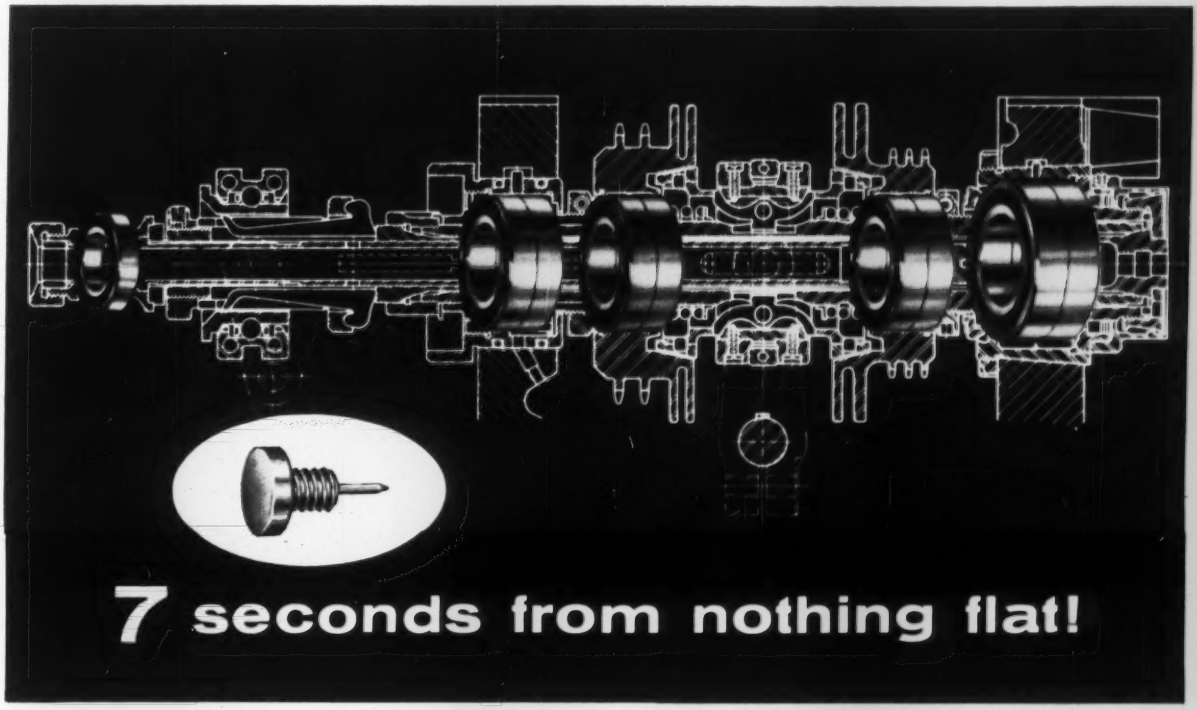
With the trend toward higher pressure requirements, American Blower has designed and built centrifugal compressors to furnish air for these heavier duties. These compressors incorporate the use of a horizontally split, welded steel volute casing, variable inlet guide vanes, welded steel impeller of the shrouded type with impeller shaft supported by two journal bearings plus a Kingsbury thrust bearing arranged for positive-forced-feed lubrication. This highly efficient compressor is driven by a 1000 HP, 1800 rpm, induction motor, delivers 330,805 pounds of air per hour at a static discharge pressure of 67.5 inches water gauge.

Like every American Blower single-stage centrifugal compressor — 30 to 2250 HP — this compressor has been completely tested in accordance with the A.S.M.E. Power Test Code. Such testing guarantees the mechanical operation and performance of all American Blower compressors. American Blower Division of American-Standard, Detroit 32, Michigan. In Canada: Canadian Sirocco products.

AMERICAN BLOWER

Division of AMERICAN-Standard

Outstanding features: (1) Improved scroll-shaped casing design. (2) Unobstructed long diffuser passage converts velocity energy into pressure, contributes to quiet operation. (3) Annulus packing minimizes recirculation of gas around impeller inlet. (4) Removable inlet nozzle for accurate alignment of annulus packing. (5) Aero-dynamic design of impeller blades for high efficiency, long life. (6) Welded-steel baseplate "stress relieved" prior to machining.



7 seconds from nothing flat!

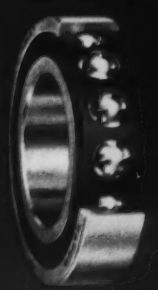
The brass part illustrated below the diagram is produced on the new 00 Brown & Sharpe Automatic Screw Machine in 7 seconds. That represents a 42% increase in production over the previous model.

To step up production by such a substantial percentage involved the development of new and exclusive features for the 00 machine over and above those proven so successful on the previous model. Included among them is the chain-driven, ball bearing spindle . . . see large diagram above.

In the selection and application of the bearings for the 00 spindle, Fafnir engineers worked with Brown & Sharpe engineers. The 208 speed combinations from a high of 7200 RPM to a low of 34 RPM, permitting high cutting efficiency on a wide range of materials, presented no ordinary problem for bearings. The bearing arrangement shown meets an exacting demand for maximum radial and axial rigidity to assure true balance and running accuracy of the spindle.

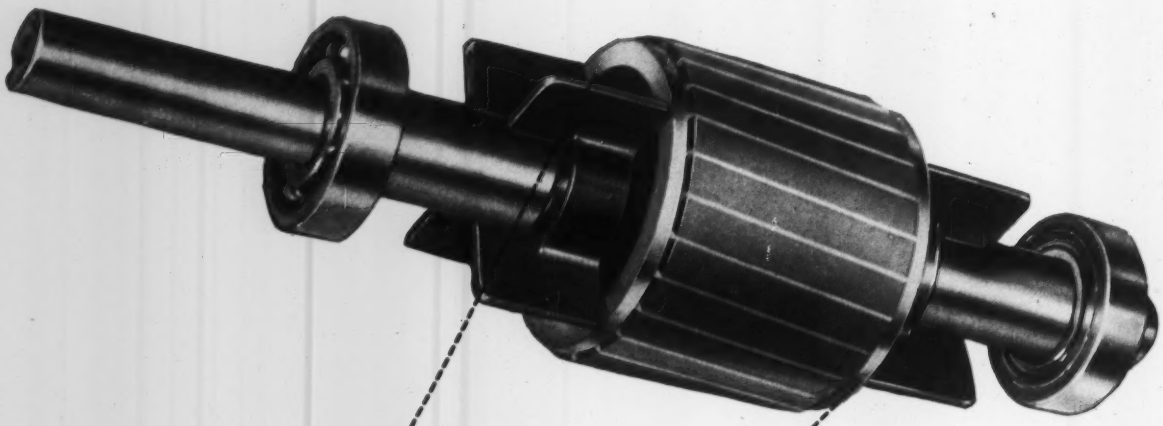
Could be there's no place in your machines for these super-precision bearings. But, whenever bearings are involved, there's certainly a place in your product planning for the Fafnir "attitude and aptitude" — a way of looking at bearing problems from the designer's viewpoint plus coming up with the right bearing to fit the need. Ask your Fafnir representative for details. The Fafnir Bearing Company, New Britain, Conn.

The New Brown & Sharpe No. 00 Automatic Screw Machine with Fafnir-equipped spindle.



Fafnir preloaded, angular-contact, super-precision ball bearings with composition or brass retainers are made to highest industry-approved tolerances. Single or duplex bearings like this are used widely on spindle applications.

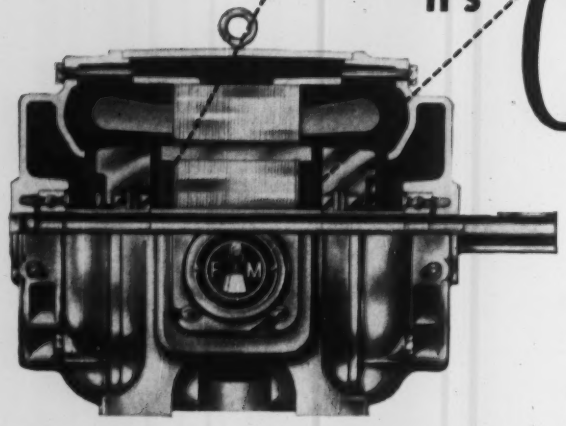
FAFNIR
BALL BEARINGS
MOST COMPLETE LINE IN AMERICA



When you want motor performance

You want this Rotor design...

it's Copperspun



Long life, stamina and high efficiency—made possible by the Copperspun rotor found only in Fairbanks-Morse polyphase squirrel-cage induction motors.

Before specifying motors for sustained, heavy-duty drives, compare designs of the all-important rotor.

Fairbanks-Morse Copperspun rotors have the mechanical strength and the superior electrical and thermal characteristics of copper. Compare these advantages against aluminum or white metal alloys. Exclusive F-M method of centrifugal casting produces a truly one-piece rotor that is homogeneous, free from flaws and gas inclusions—virtually indestructible. It is accurately machined and dynamically balanced for longest trouble-free service on the toughest application.

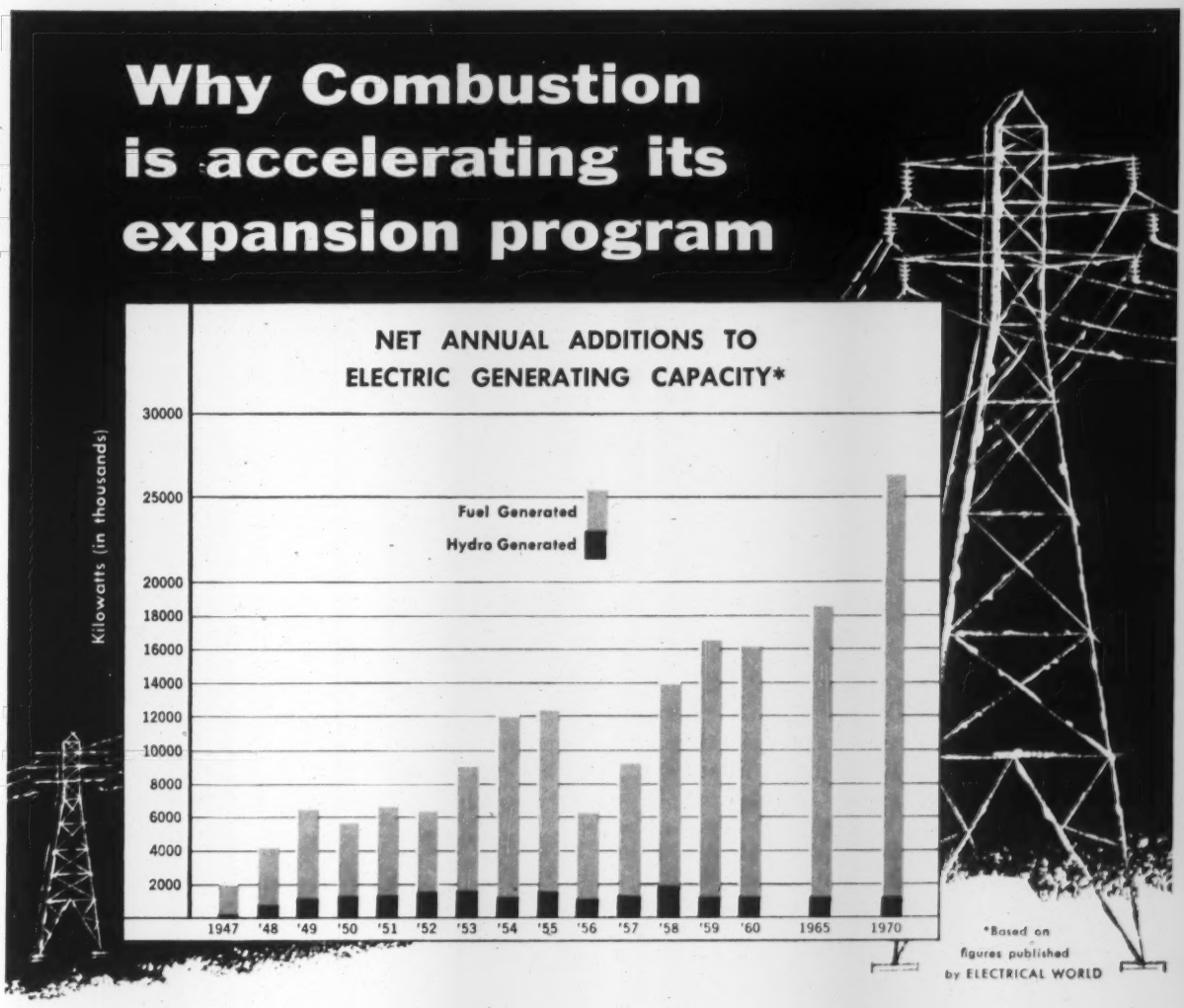
The Copperspun rotor and the Fairbanks-Morse standard of quality manufacture make it more than worth your while to get in touch with the motor specialist from Fairbanks, Morse & Co., Dept. ME-2, Chicago 5, Ill.

FAIRBANKS-MORSE

a name worth remembering when you want the BEST

ELECTRIC MOTORS AND GENERATORS • DIESEL LOCOMOTIVES AND ENGINES • PUMPS • SCALES • RAIL CARS • HOME WATER SERVICE EQUIPMENT • MOWERS • MAGNETOS

Why Combustion is accelerating its expansion program



The chart shows the rate at which America's utility industry has been expanding for the past decade and its projected rate of expansion to 1970. What this rate of growth means is dramatically illustrated by the fact that the total new capacity to be installed in the next decade will substantially exceed the total capacity the utility industry has attained in the 75 years it has been in existence.

Because electrical consumption reflects our national prosperity and living standards, this chart also indicates the progress we have been making as a nation and the progress we can anticipate for some years to come. It is doubly significant to us at Combustion since the largest part of our dollar volume comes from sales of utility boilers, and the second largest part from sales of boilers and other equipment to industry whose annual rate of growth roughly parallels the rate of power expansion.

To keep abreast of power expansion, Combustion increased its manufacturing capacity *more than 50 per cent* in the five-year period ending in 1955. And it is now engaged in the biggest expansion program in its history — not only to assure its ability to meet the ever-growing demand for conventional boilers, but also to prepare itself for a major role in the rapidly developing field of nuclear power.

In its expansion, as well as in its research and development work, Combustion's objective is to build boilers today that will set *tomorrow's* standards of performance. Whether your steam requirements be large or small, you can depend on C-E Boilers to give you the best in economy and reliability.

COMBUSTION ENGINEERING C-E

8-9/5

Combustion Engineering Building

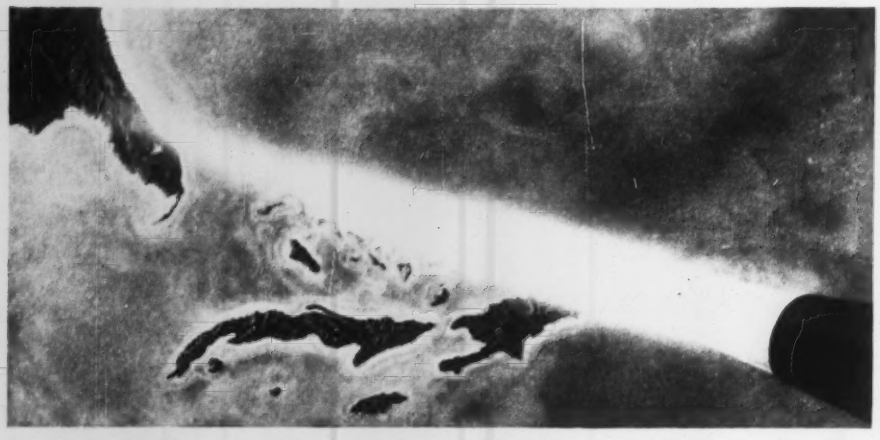
200 Madison Avenue, New York 16, N. Y.

all types of steam generating, fuel burning and related equipment; nuclear reactors; paper mill equipment; pulverizers; flash drying systems; pressure vessels; said pipe

Wanted!

Engineers to sign on for one of the most exciting scientific expeditions of our time:

The SM-64 Navaho Missile



The men behind this invitation are pioneers in missile development. Ten years ago they started from scratch. There were no texts to consult, no rules to follow. Today their technological achievements are so great ... their jobs so broad ... there is room at every level of engineering for additional mindpower.

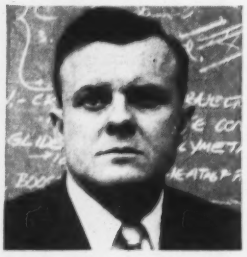
Accept this challenge and you can travel faster and farther than you ever thought possible on one of the most important programs in the free world today—North American's complete weapons system responsibility for the Air Force SM-64 Navaho Intercontinental Strategic Guided Missile.

DOUGLAS K. BAILEY received his BS degree from the University of California. He joined North American ten years ago as a senior design engineer. Today he is chief, Missile Design Section—responsible for missile design engineering and analysis. Doug and his family live in Long Beach where he participates in golf, bowling and sports car activities. He is currently organizing road races in Southern California for the Long Beach MG Club.

Unprecedented programs have been completed and more are to come. Others are being developed, modified and perfected as we enter another exciting phase following a successful flight test program at Patrick Air Force Base using a test vehicle known as the X-10.

The fascinating nature of this work has already attracted the world's best informed missile men. Top-tier men have opportunities in almost every field of engineering—including some of the most advanced work being done today in aerodynamics, thermodynamics, high temperature materials and aero-elasticity.

Solving these problems is bringing forth new formulae and new production techniques. One example is Chem Mill, the process of shaping metals—including titanium and newest alloys—to previously unattainable designs by chemical etching. This method reduces weight ... increases strength. The idea came from a North American Missile engineer.



Navy vet **GEORGE W. JEFFS** earned both his BSAE and MSAE from the University of Washington. About 9 years ago he started his professional career with North American as a junior aerodynamics engineer. Now, 5 promotions later, this 30-year old veteran of missile work is chief, Advanced Design Section. He lives in Downey, California with his wife and 3 children. His hobbies include fresh-water fishing and hunting for quail and pheasant.

This is the kind of opportunity open to you. You can share our knowledge and add to it.

Recent graduate engineers can step into established groups. Experienced men will find even greater opportunities in the new groups that are being formed. And you'll do this in a management climate that stimulates personal growth and rewards it with responsibility, professional recognition and material benefits. Further, you can continue your studies with the aid of North American's Educational Refund Plan ... live and work in Southern California ... in near-ideal climate.

Let us know what kind of creative engineering interests you. (Please include highlights of your education and experience.)

Write today to: Mr. R. L. Cunningham, Engineering Personnel Manager, Dept. 91-2-ME
Missile Development Division, 12214 Lakewood Blvd., Downey, California.

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for handling materials as diversified as corrosive fluids, gases, beverages, viscous materials, foods, compressed air, solids in suspension.

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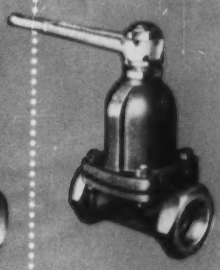

Lever Operated

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Unsurpassed on lines where corrosion, abrasion, contamination, clogging, leakage and maintenance are costly factors.

In industries as varied as mining, food, textile, pulp and paper, beverage, water and sewage, chemicals . . . Grinnell-Saunders Diaphragm Valves continue to win enthusiastic acceptance. The unique design of the valve — with its flexible, long-wearing, tight-closing diaphragm — offers many unusual advantages.

If you have a valve problem, it will pay you to write Grinnell for further information.

Choice of Materials

Bodies — iron; cast steel; stainless steel; Durimet 20; Hastelloy A, B, C; bronze; Monel; aluminum; PVC (polyvinyl chloride); Saran

Body linings — hard rubber; soft rubber; neoprene; glass; lead; plastics; Heresite; Lithcote

Diaphragms — soft natural rubber; natural rubber; white synthetic rubber; neoprene; reinforced neoprene; butyl; Hycar; Teflon; Kel-F; PVC (polyvinyl chloride); polyethylene

Bonnets — iron; stainless steel; bronze; other materials on special order

Choice of Bodies

Conventional weir type

Straight bodies — screwed; flanged; socket weld; butt weld; socket (solder); sanitary threads; hose ends; Victaulic

Angle bodies — screwed; flanged; socket weld

Other types

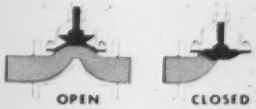
A line of Straightway Valves (for straight-thru flow) and Full-Bore Valves (for ball brush cleaning) also are available

Choice of Bonnets

Handwheel (non-indicating stem, indicating stem); chain wheel; lever (for quick operation); sliding stem (for a wide selection of power operated topworks)

Operating Features

- diaphragm absolutely isolates bonnet mechanism from the fluid in the line
- diaphragm lifts high for streamline flow in either direction
- diaphragm presses tight for positive closure
- simple maintenance — diaphragm easily replaced without removing valve body from line



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Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
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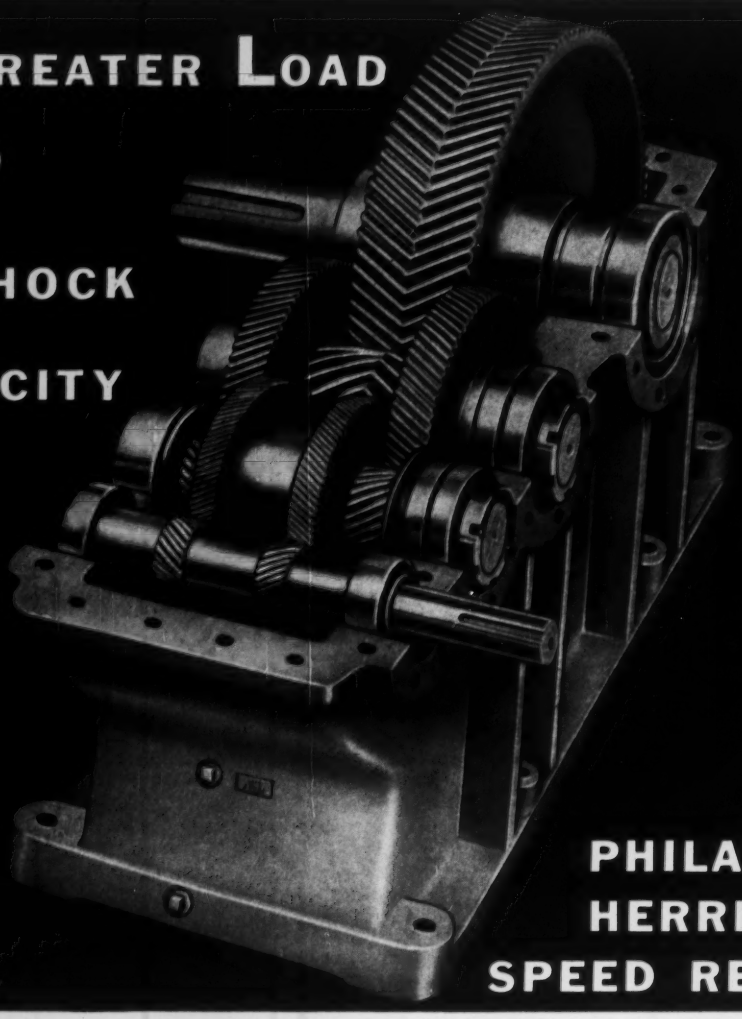

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Send for new 48-page catalog . . . contains complete design and application data on these widely used, highly efficient units.

Where you have a machine drive that requires high horsepower speed reduction under grueling load and shock conditions, specify Philadelphia Continuous Tooth Herringbone Speed Reducers . . . Built to withstand the most severe round-the-clock operation, these Reducers offer you extra service dividends through high efficiency, greater strength, and years of quiet, trouble-free operation.

Herringbone and Helical Gear teeth are precision cut for maximum tooth contact and overlap . . . assure uniformity of torque and freedom from damaging vibration.

Gears and Pinions are arranged symmetrically within rugged, compact housings, which assures equal loads on each shaft bearing, and minimizes the most severe stresses. Fully enclosed, self-contained housings prevent oil leakage . . . no parts such as glands require adjustment . . . more than ample oil reservoir assures cool correct lubrication. Available in single, double and triple reductions covering a range of ratios from 1.75:1 up to 292:1, Philadelphia Herringbone Reducers provide optimum performance at minimum cost.

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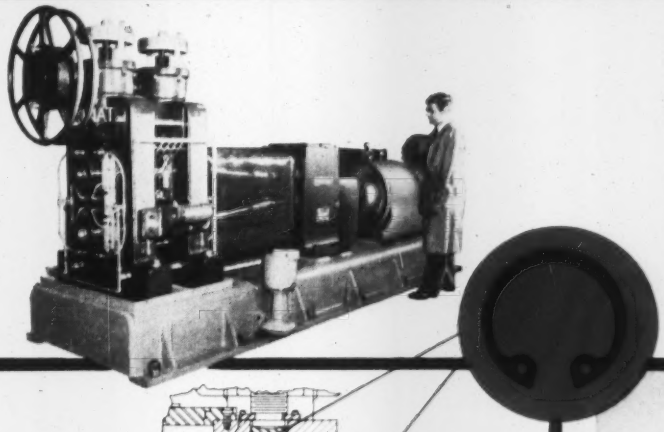
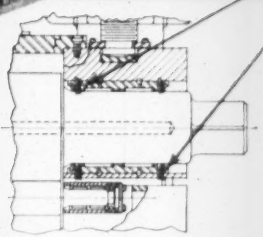
7-inch Waldes Truarc retaining rings cut costs, speed assembly-disassembly of 2-high/4-high mill

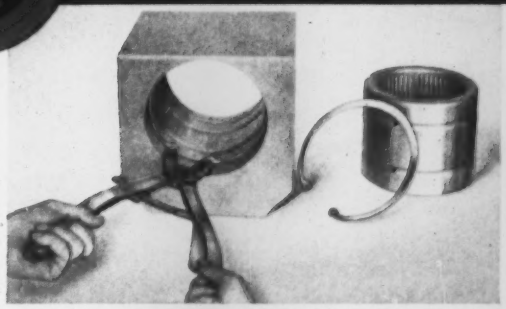


New Model TA-625 2-high/4-high combination rolling mill designed by Stanat Manufacturing Co., Long Island City, N. Y., reduces 2½" ingot to precision-rolled strip as thin as .001".

Waldes Truarc retaining rings help make possible a complete change of work rolls in 20 minutes...solve difficult problems of accuracy control by achieving positive location of bearings to extremely close tolerances. Rings eliminate costly parts and machining, save space, reduce maintenance.



In the assembly illustrated above, 7" Waldes Truarc (Series 5000) retaining rings—three on each roller—are used to position heavy-duty needle bearings in the bearing housing. Smaller rings position bearings in other roller assemblies and retain the shaft of a dual handwheel screwdown. All in all, 18 Waldes Truarc rings are used in the mill. They replace machined shoulders, spacers and lock nuts...eliminate costly threading, other machining operations.



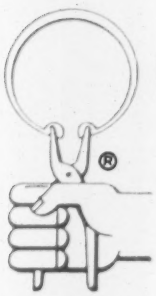
Assembly is simple, even with giant 7" diameter Truarc ring. Special Truarc ratchet pliers grasp the ring securely, ease it into the groove, snap it securely into position. Smaller pliers and various high-speed assembly jigs are available for other rings, permit assembly-disassembly to be performed rapidly even by unskilled labor.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product...to save you material, machining and labor costs. Quick and easy to assemble and disassemble, they do a better job of holding parts together. Truarc rings are precision-engineered and precision-made, quality controlled from raw material to finished ring.

36 functionally different types...as many as 97 different sizes within a type...5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U.S.A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today...let our Truarc engineers help you solve design, assembly and production problems...without obligation.

For precision internal grooving and undercutting...Waldes Truarc Grooving Tool!



WALDES

TRUARC®

RETAINING RINGS

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ME-029

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

How perfectly simple —this Fast's Coupling with purely mechanical flexibility!

1. A hub is keyed on each shaft. Hubs are splined at maximum distance from shaft ends.
2. Floating sleeves surround hubs. Sleeves are splined to engage hub splines.
3. Sleeves compensate for shaft misalignment by assuming neutral position between two hubs.
4. Because of distance from shaft end, any misalignment between splines is mere fraction of same misalignment between shafts.
5. Sleeves carried on bearing rings, located on transverse center line of hub spline faces (the load-carrying surfaces) — no crank action, no vibration.
6. Lubricant is centrifugally forced into spaces between engaged splines, forming a film.

For 35 years the most positive, dependable means of coupling machines to their power source . . . Fast's Couplings have no parts subject to repeated bending, tension or compression. Because there is no metal-to-metal contact, *there is no wear*—in fact, many Fast's Couplings in use for over 30 years show no signs of wear when disassembled! No leather, plastic or rubber oil seals. Lubricant film distributes pressure over a considerable area, diminishing localized stress at pressure points on the load-carrying teeth. Perfectly simple? Yes . . . and foolproof!

For coupling catalog, technical advice or assistance from Koppers field engineers, write: KOPPERS COMPANY, INC., *Fast's Coupling Dept.,* 3402 Scott Street, Baltimore 3, Maryland.

THE ORIGINAL **FAST'S Couplings**

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***Engineered* Products Sold with *Service*.**

A Multipress case study

Small lot production of intricate electronic parts is performed quickly and economically on this Denison hydraulic Multipress.

MULTIPRESS® speeds electronic parts assembly at General Radio

The Problem: Planning a production set-up for a company that averages a new, complex electronic instrument every month, in production lots ranging from 50 to 100,000 units.

The solution: Denison's versatile hydraulic Multipress.

General Radio Company of Cambridge, Mass., a leading designer and manufacturer of electronic test equipment, finds Multipress capable of automatic operations on volume runs, yet efficient when manually operated for small lots.

Small lot production costs have been reduced substantially. Operator safety is at peak levels. Smooth, precise pressure control produces uniform assemblies despite thickness variations in stock materials.

These Multipress benefits are typical. To find out how Denison hydraulic power can lower costs, speed production and improve quality for your company, consult a Denison hydraulic specialist. Write Denison Engineering Division, American Brake Shoe Co., 1174 Dublin Road, Columbus 16, Ohio.

DENISON HydrOILics

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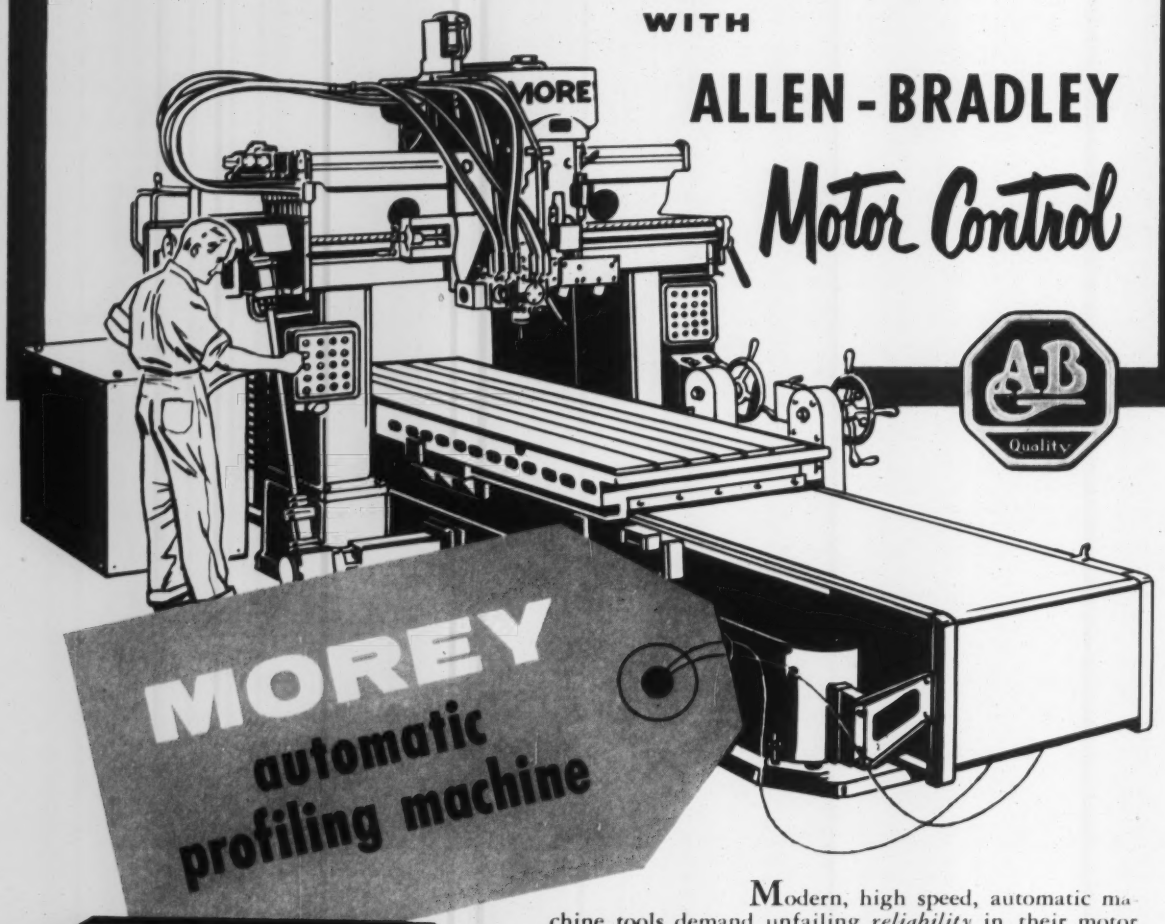
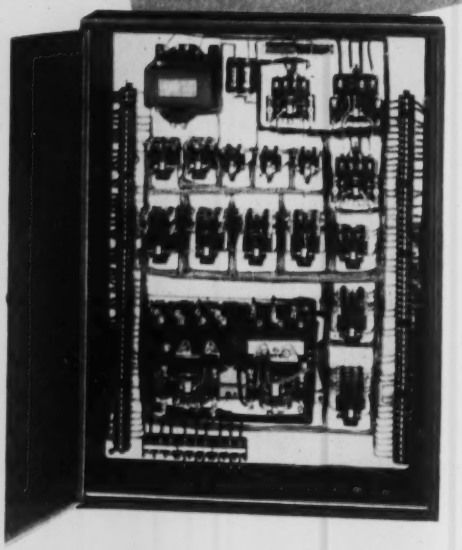
FACTORY EQUIPPED WITH ALLEN-BRADLEY *Motor Control*





Special Control Panel for the Morey Automatic Profiling Machine. This panel consists of an assembly of standard units listed in the Allen-Bradley Handy Catalog.

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SOLENOID MOTOR CONTROL
QUALITY

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Crucible's REX® high speed steel always scores highest on performance—as it has for more than a half century. That's because it is consistently sound and uniform in structure . . . with dependable response to heat treatment.

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REX is immediately available at all Crucible warehouses, or on prompt mill delivery. For a list of helpful data on REX and other *special steels*, write for a free copy of the "Crucible Publication Catalog." *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

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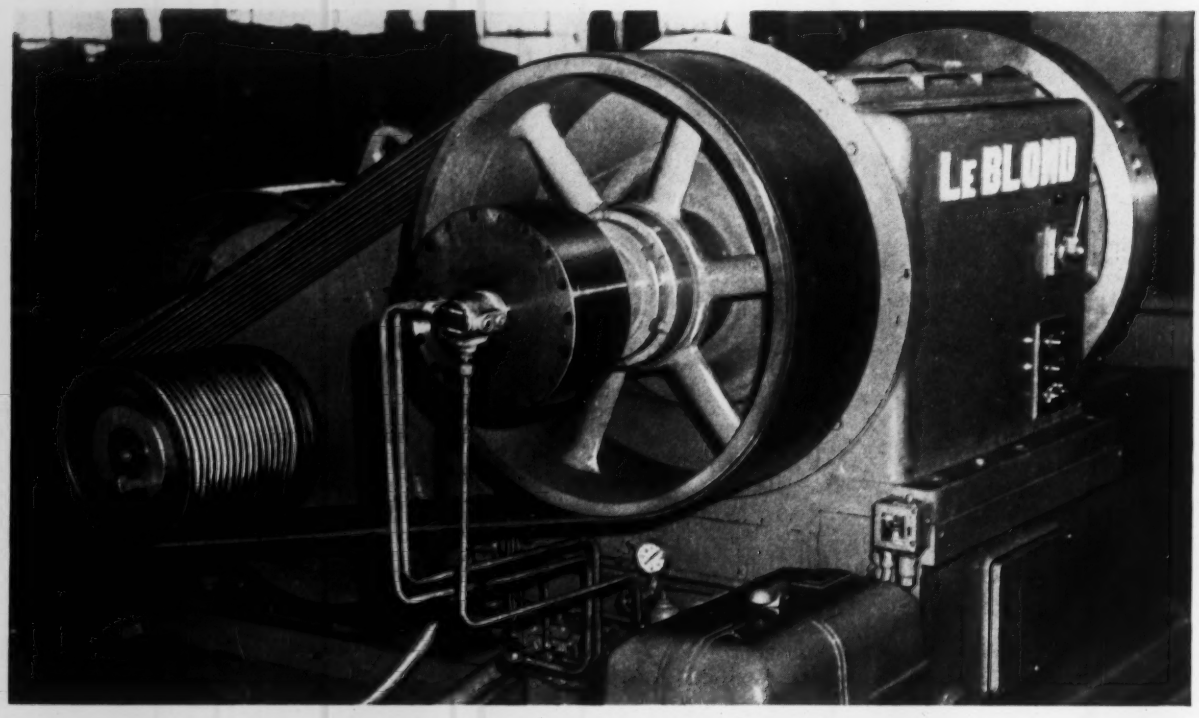

NEW R/M *Poly-V*® *Drive*

Solves Seven Major Power Transmission Problems!

Heavy duty drive problems can be accepted as necessary and costly features of power driven equipment—or they can be overcome! The difference is Poly-V* Drive . . . R/M's patented new concept in heavy duty power transmission. Here's how R/M Poly-V Drive helps eliminate seven major problems common to most conventional V-belt drive applications.

BELT MATCHING—Poly-V employs a single unit, V-ribbed endless belt running on specially designed sheaves—not a series of V-belts which vary in length. Belt length matching problems are completely eliminated!

SPEED RATIOS—Full contact between belt ribs and sheave grooves prevents belt "sinking" and uneven speeds . . . maintains constant speed ratios and effective pitch diameter from *no* load to *full* load!

SPACE REQUIREMENTS—Greater horsepower capacity per inch of sheave width with Poly-V delivers up to 50% more power in the *same* space as a multiple V-belt drive . . . or *equal* power in as little as ⅔ the space!

DRIVE LIFE—Poly-V Drive has *twice* the contact area with only *half* the face pressure and that means *less* wear, *longer* life for both belt *and* sheaves!

STOCK INVENTORIES—Just *two* cross sections of Poly-V Belt meet *every* heavy duty power transmission requirement, as compared to *five* in the case of V-belts. With Poly-V you keep belt and sheave inventories to an all time low!

HEAT PROBLEMS—Because thinner Poly-V Belts have twice the ribbed area of V-belts exposed to the air, you are assured *cooler* operation and less strain on your equipment. And, of course, Poly-V Belt construction is heat resistant, oil-proof and non-spark!

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If any—or *all*—of these features can help improve your heavy duty power transmission drive performance and dependability, you owe it to yourself to investigate R/M Poly-V Drive. R/M engineers who developed it will be glad to assist you in determining the Poly-V Drive installation that will best solve your problems . . . give you "More Use per Dollar."

*Poly-V is a registered Raybestos-Manhattan trademark.

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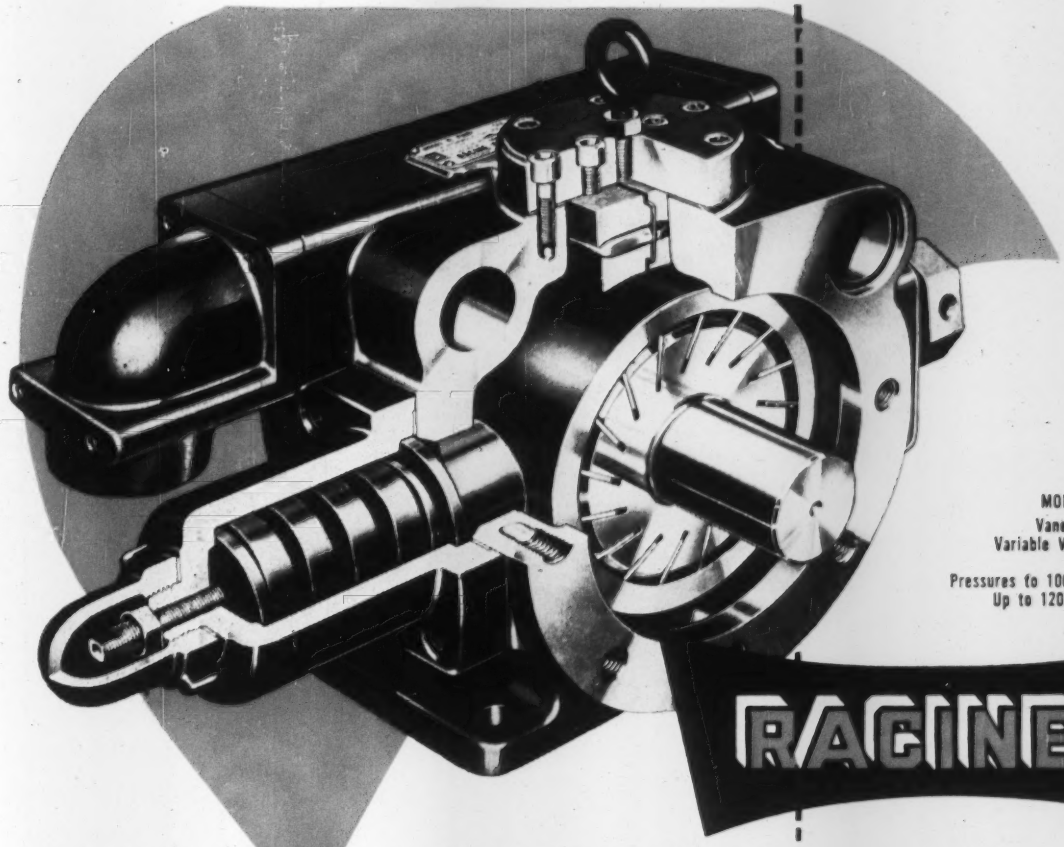

MODEL K
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Pump
Pressures to 1000 psi
Up to 1200 rpm

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WHY WASTE HORSEPOWER?

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Why waste horsepower? Write today for complete information.

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Pressures to 1500 psi

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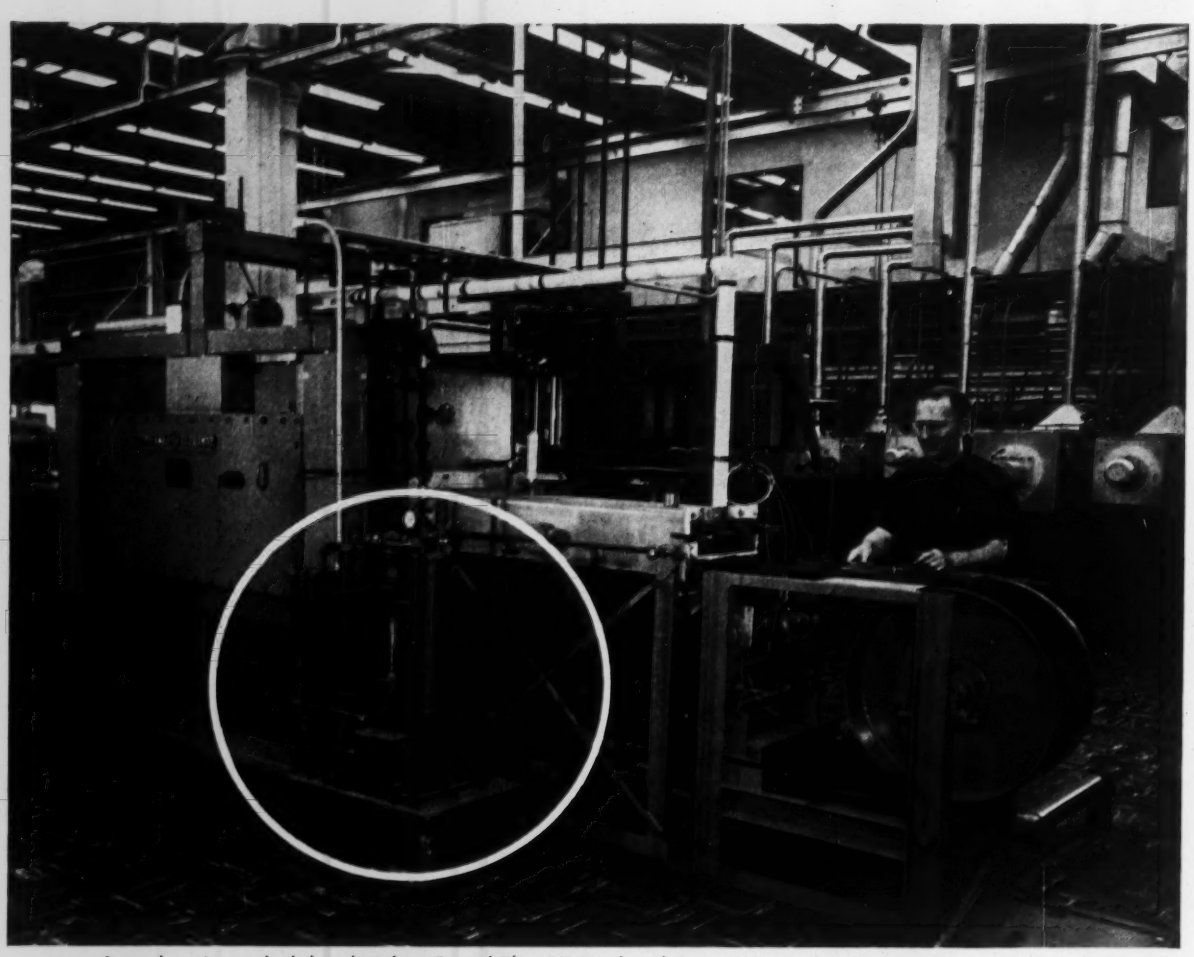

Lectrodryers are wheeled to the job at General Electric's Metals and Ceramics Research Laboratory, Schenectady, N. Y.*

DRYing on wheels aids Research

If it's an experimental job requiring a DRY controlled atmosphere, plug the Lectrodryer into power and it dries the gas as it enters the furnace. Where DRYing is an everyday requirement, of course, a Lectrodryer is permanently mounted near the furnace or at the central gas source.

Researchers use Lectrodryers to standardize methods, then specify them for production plants. Manufacturers of gas generators supply Lectrodryers as standard equipment when DRY atmospheres are required.

Because Moisture Isn't Pink describes DRYing installations in many industries. For a copy, write Pittsburgh Lectrodryer Company, 335 32nd Street, Pittsburgh 30, Pennsylvania (a McGraw Electric Company Division).

Lectrodryer

*REGISTERED TRADEMARK U. S. PAT. OFF.

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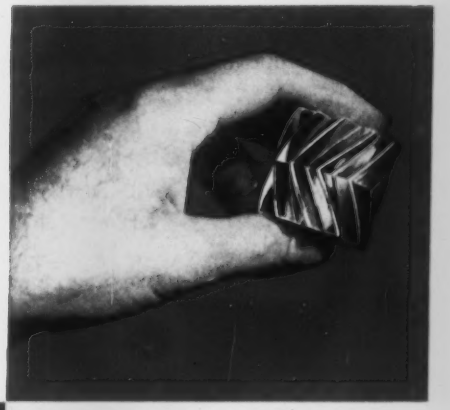
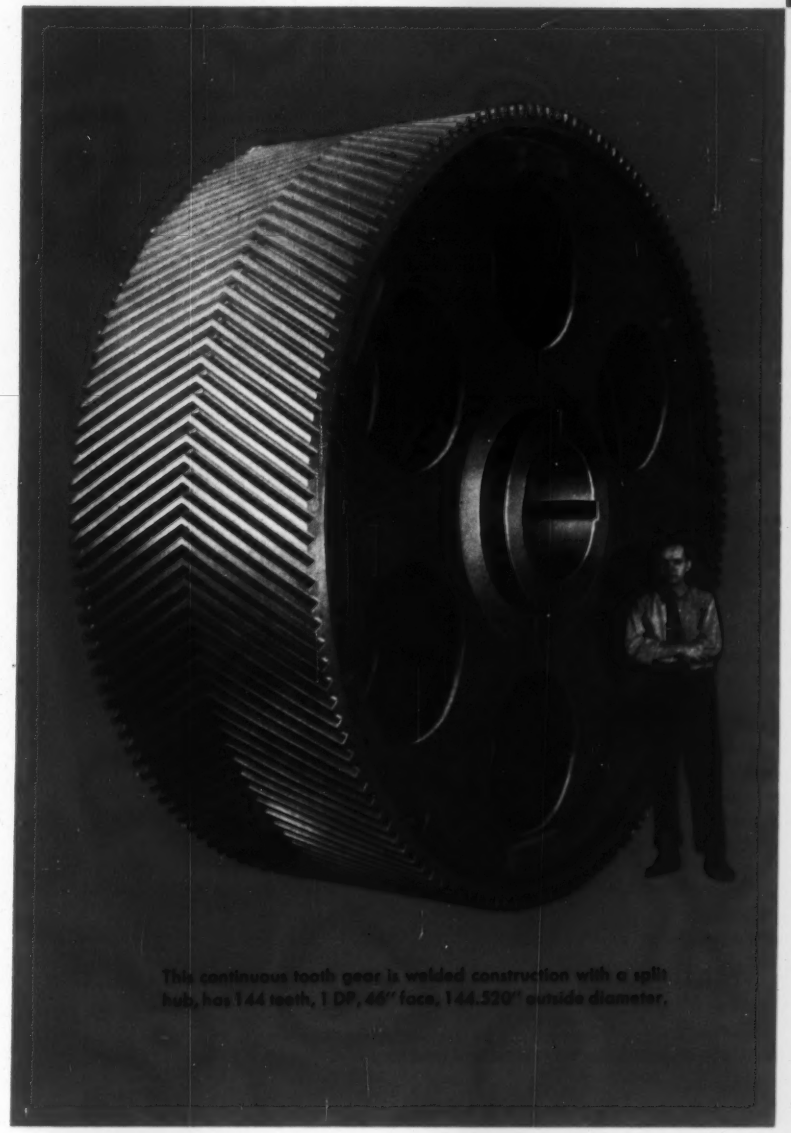
comes in any size up to 23' for any power capacity





This continuous tooth gear is welded construction with a split hub, has 144 teeth, 1 DP, 46" face, 144.520" outside diameter.

Farrel continuous-tooth herringbone gears are made in a complete range of sizes from ¼ inch to 23 feet diameter, ¼ to 60 inch face, 24 DP to 0.75 DP, for any power capacity and any application.

The backbone in Farrel herringbone gears, formed by the meeting of the two helices without a center groove, puts the entire face width of the gear to work for you. This pays off in extra strength and greater load and shock capacity—ideal for heavy-duty applications.

Farrel can also supply straight tooth (spur) gears, single helical gears and internal gears in a wide range of sizes—all precision-generated on Farrel-Sykes machines.

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Coverage: The entire field from basic theory to experimental techniques.

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*Frequency-Response Analysis of Continuous Flow Systems—H. Kramers and G. Alberda (Holland)

*Response and Phase-lag of Thermometers—E. G. J. Eykman and C. J. D. M. Verhagen (Holland)

Transient Response

Determination of Transient Response From Frequency Response—A. Leonhard (Germany)

The Use of Zeros and Poles for Frequency Response or Transient Response—W. R. Evans

*A Method of Estimating Dynamic Characteristics of Physical Systems—S. Lees

Optimum Controls

A Uniform Approach to the Optimum Adjustment of Control Loops—R. C. Oldenbourg

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Nonlinear Techniques

*On Some Nonlinear Phenomena in Regulatory Systems—L. C. Goldfarb (Russia)

Recent Advances in Nonlinear Servo Theory—J. M. Loeb (France)

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Stability Characteristics of Closed-Loop Systems With Dead Band—C. H. Thomas

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THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
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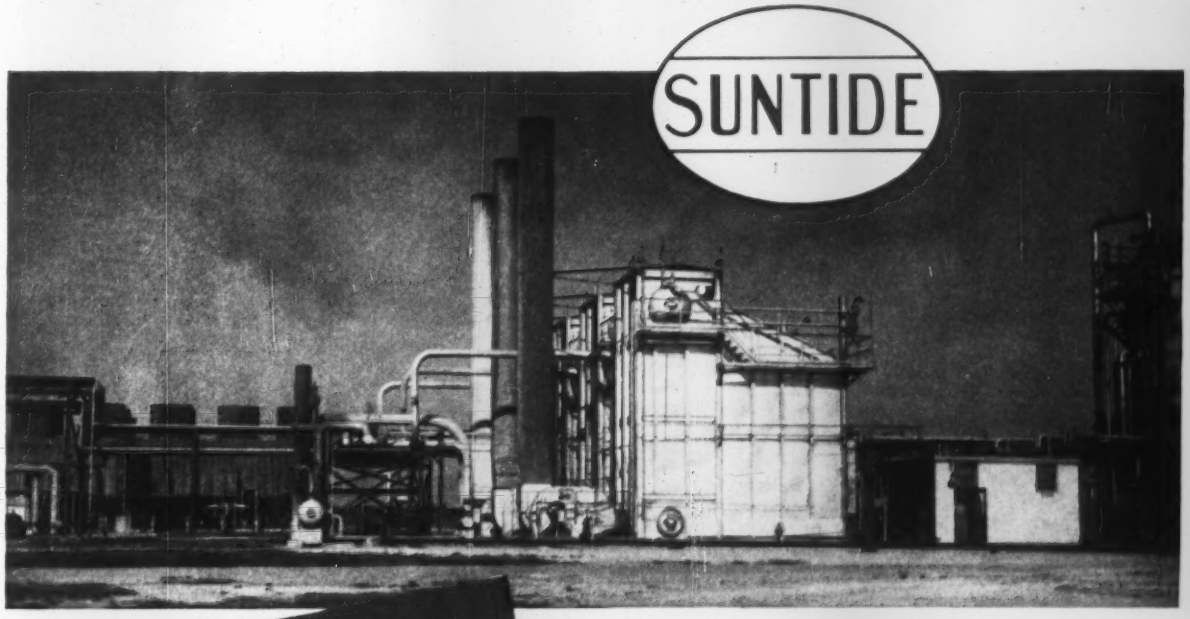
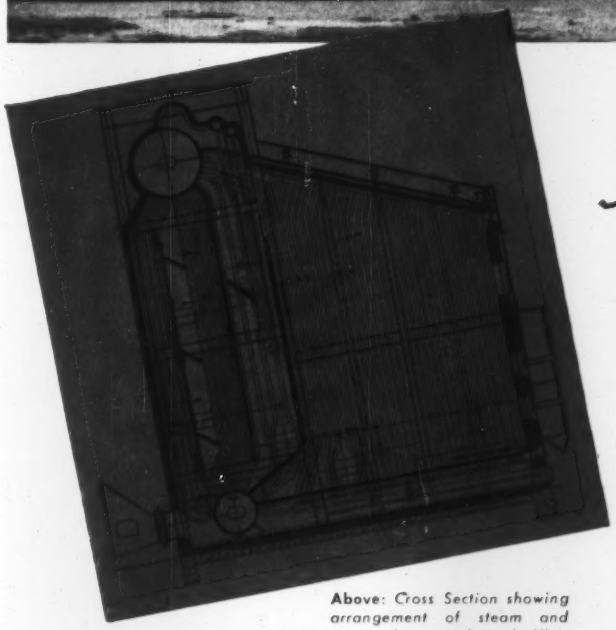
Vogt STEAM GENERATORS

at **SUNTIDE REFINING COMPANY**
Viola, Texas





Above: *Cross Section showing arrangement of steam and water drums, tubes, baffles, and furnace.*

3 Units Installed 2 Units on Order

Principle Data Each Unit

- 85,000 pounds steam per hour capacity, designed for 500 lbs. S.W.P. and 625° F. total temperature.
- Water cooled furnace.
- Burners for Gas and Oil fuel.

Vogt offers a complete line of custom built and package type steam generators. Available in bent tube and straight tube designs for solid, liquid, or gaseous fuels burned singly or in combination.

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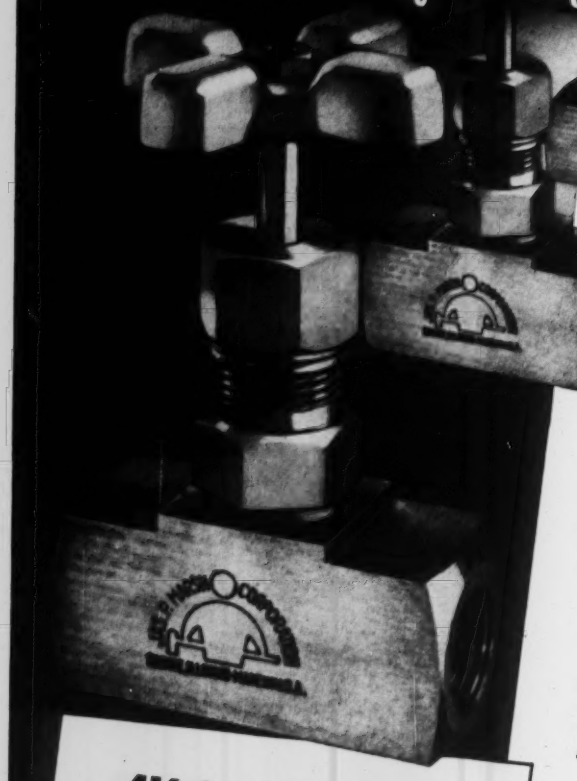
Now the finest of needle valves is available



416 Stainless throughout...

In the Marsh Needle Valve, operating men found a valve that was better all the way through. Then came the call for a valve of like quality and precision for corrosion service... to be 416 stainless steel throughout.

The valve illustrated here is the answer. Like the parent valve, this new valve has safety and strength to spare . . . guaranteed for working pressures up to 10,000 psi . . . equally efficient and effective in any lower pressure range.

It too is machined from solid bar stock—in this case, 416 stainless steel. Its precision-ground and-machined stem is hardened 416 stainless. Packing is the special "Marpak" ring . . . one-piece, non-binding, long-lasting. So finely built is this needle throttling and cut-off valve that it can be easily throttled down to exceptionally fine regulation even on extreme pressure.

Read the list of features opposite. Then write for new bulletin No. NV-2 containing complete details.

The new all stainless valves (Series 1924) includes globe and angle patterns with double female connections in sizes ⅛", ¼", ⅜", ½", ¾", 1"; also globe and angle valves with male inlet and female outlet in sizes ¼" and ½".

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416 Stainless Steel ...all the way through!

- Body and stem guide machined from bar stock.
- Valve stem, hardened stainless.
- Packing, special Marsh "Marpak" moulded ring.
- Fine stem threads for strength and precision throttling.
- Deep inlet and outlet thread chambers.
- Bodies marked in accordance with MSS regulations.

Maximum Working Pressure 10,000 P.S.I.

Water, oil, gas or corrosive fluids not injurious to 416 stainless steel.

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KELLOGG'S FIELD CONTROL KEEPS PACE

All high and low pressure steam piping for the 225,000-kw turbine-generator at Appalachian Electric Power Company's Glen Lyn, Virginia, station was fabricated and erected by M. W. Kellogg—using local union labor. Initial steam conditions are 1050 F, 2000 psi, with reheat at 1050 F. Main steam lines are 2¼% chrome-1% molybdenum, 12¾ in. OD, 2¼ in. average wall thickness. To meet the exacting requirements of both American Gas and Electric Service Corporation and The M. W. Kellogg Company, close control of techniques and procedures was doubly important.

At Glen Lyn, as elsewhere in the field, M. W. Kellogg's reputation for completing a power piping project efficiently and promptly is due to the right techniques, the right materials, the right equipment, and—equally important—the right men to train and supervise labor to Kellogg's special standards. We welcome the opportunity to demonstrate these unique abilities and facilities. Some of them, including K-Weld*, are described in our 12-page booklet, "For The Modern Central Power Station." Write for your copy.

(Above) An inspector on Kellogg's permanent staff supervises welding of main steam lines at the Glen Lyn Station. (Below) Controls for the gang of 40-kva stress relieving units at Glen Lyn provide a permanent record of preheating, concurrent heating, and stress relieving cycles, ranging from room temperature to 1350 F.

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POWER PIPING—THE VITAL LINK

•Trademark and patented by The M. W. Kellogg Company

No repairs, no maintenance for these Crane valves —after 12 years on feed-water service

The day these Crane steel valves were installed 12 years ago, they started saving money for the Neches Butane Products Company's butadiene plant in Texas.

Not once have these 8-inch No. 76½ XR steel gate valves required repairs—not once have they needed maintenance . . . and they've been on hard, continuous service on lines to boiler feed pumps in this 3 million pound-per-hour steam plant.

There's more than meets the eye to valve service like this. From the outside, the average person wouldn't know the difference between Crane valves and others of the same type. That's why those who know valves investigate the *inside* quality before they specify. When the valves are Crane, they don't have to look far to find this quality—quality in materials, engineering and construction that literally means the difference between long, cost-free performance and expensive, aggravating, down-time maintenance.

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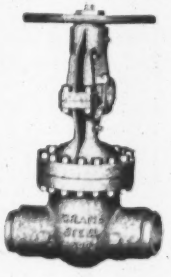
Get full information from your local Crane Representative, or write to address below.



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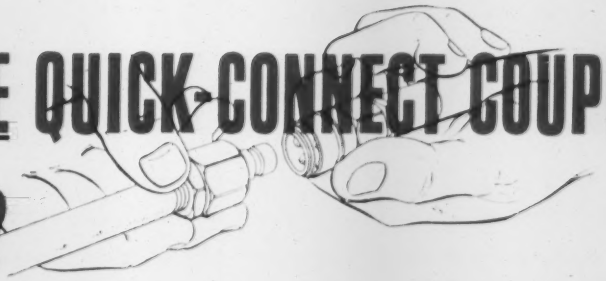
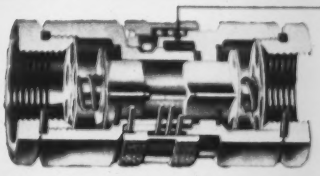


SNAP-TITE "H" COUPLING . . . . . FOR HIGH PRESSURE APPLICATIONS

FOR HYDRAULIC OR AIR

"H" Coupling for high strength, higher efficiency, high-resistance to heavy line surge. Sizes: $\frac{1}{8}$" thru 12". Bulletin No. 240

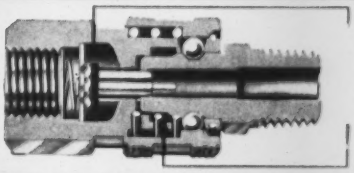


Exclusive U-packer gives a positive seal without compression set because of rubber distortion. Line pressure inside the U-packer keeps it open and forced against its metal backing—the higher the pressure, the tighter the seal.

SNAP-TITE HI-FLOW COUPLING . . . FOR LOW PRESSURE APPLICATIONS

FOR AIR AND FLUIDS UP TO 150 p.s.i.

Hi-Flow is recommended to connect small air tools to plant air system, and for low pressure fluid transfer in small lines. Sizes: $\frac{1}{8}$" thru $\frac{3}{4}$". Bulletin No. 230

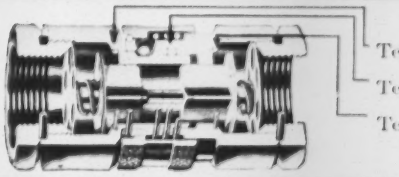


Bonded valve washer (pat. pending on valve construction)

Exclusive U-packer

SNAP-TITE "HK" COUPLING . . . . . FOR HARD TO HANDLE FLUIDS

FOR FUMING ACIDS, ALKALIES, SOLVENTS, AND HIGH PRESSURE STEAM . . . "HK" is the only coupling now on the market for fluid temperatures from —100° F to +500° F . . . and for live steam up to 460° F. Its seals are made of Teflon for which there is no known solvent. Sizes: $\frac{1}{2}$" thru 3". Bulletin No. 270



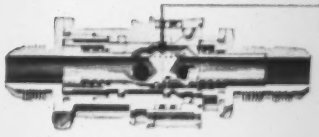
Teflon Valve Seal

Teflon Nipple Seal

Teflon Valve Seal

SNAP-TITE NO-SPILL COUPLING . . . FOR MINIMUM AIR INCLUSION

FOR AIRCRAFT, MISSILE HYDRAULIC, FUEL SYSTEMS which cannot stand air in the lines, and for transmitting fluids which *must not spill*, the Snap-Tite no-spill coupling is recommended. Bulletin No. 280

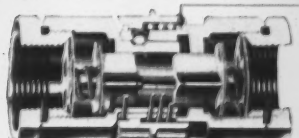


Flush valves prevent spillage, air inclusion. Snap-Tite will engineer special variations to your requirements.

SNAP-TITE "E" COUPLING . . . . . FOR VACUUM and VERY LOW PRESSURE

FOR VACUUM SYSTEMS IN THE MICRON RANGE

"E" Coupling performs in the *micron* range in the smaller sizes both connected and disconnected. Recommended, too, for gravity flow . . . U.L. approved for LP Gas. Sizes: $\frac{1}{8}$" thru 12". Bulletin No. 250



Nipple seals in coupler by depressing the lip of the E packer and slightly compressing the body of the packer. This new E-packer gives positive seal under high-pressure, low-pressure, and vacuum.

Snap-Tite Couplings are available plain, (without valves), and with either single or double shut-off. Couplings normally furnished in alloy steel, but all (except hi-flow) are also available in brass, aluminum, or stainless steel with a variety of finishes.

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Snap-Tite

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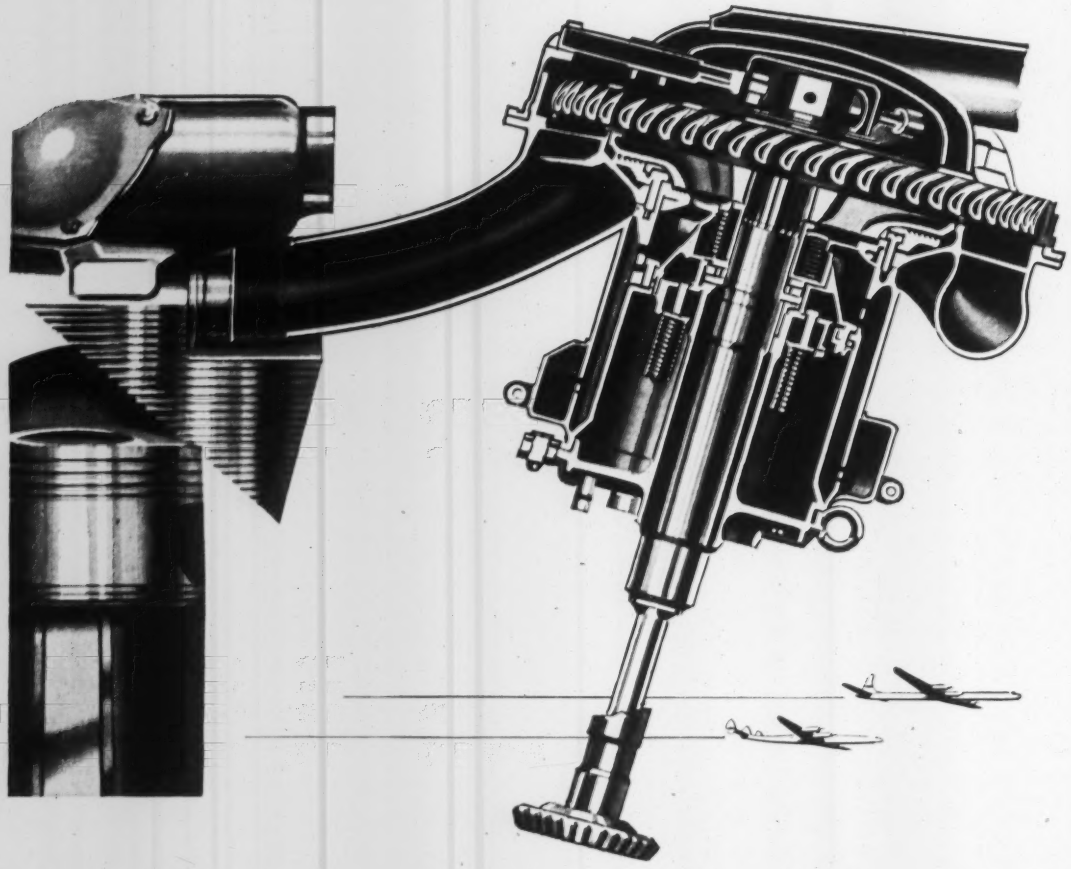
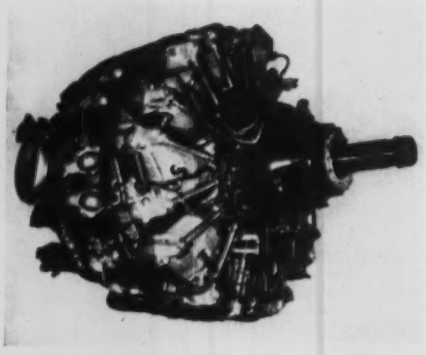


The turbine that transformed air travel



You are looking at the most important advance in airline engine design in 30 years. It's one of the turbines that add a spectacular 20 to 24%, depending on altitude, to the power of the Curtiss-Wright Turbo Compound® engine. It's a turbine that makes America's Douglas DC-7s and Lockheed Super Constellations the world's *fastest*, longest-range airliners . . . as well as the most deluxe.

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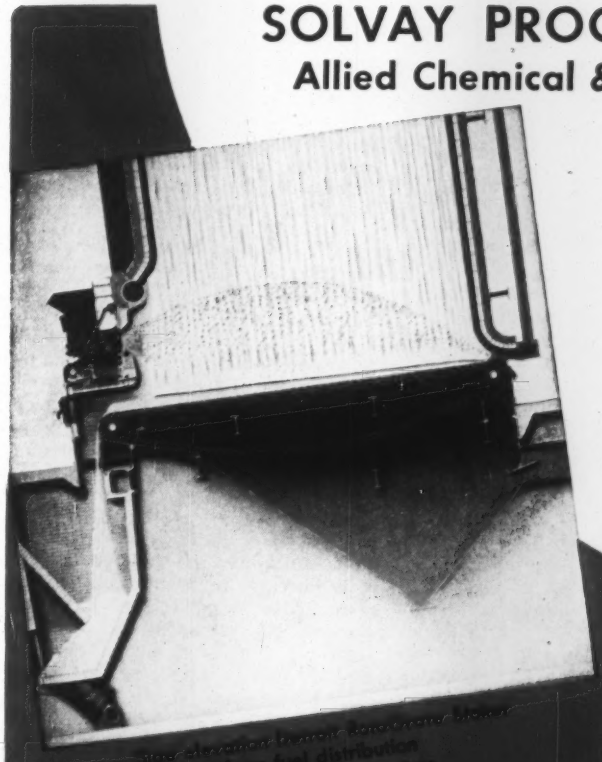
at Moundsville to Burn West Virginia Coal

Detroit RotoGrate is a modern spreader stoker with grates that move slowly forward, discharging ash at the front. It will burn any type of Bituminous coal or Lignite and many types of combustible refuse with high efficiency. Handles rapidly fluctuating loads. Produces more capacity per square foot of grate area. Precise control of fuel feed with grate speed and air supply provides smokeless operation.

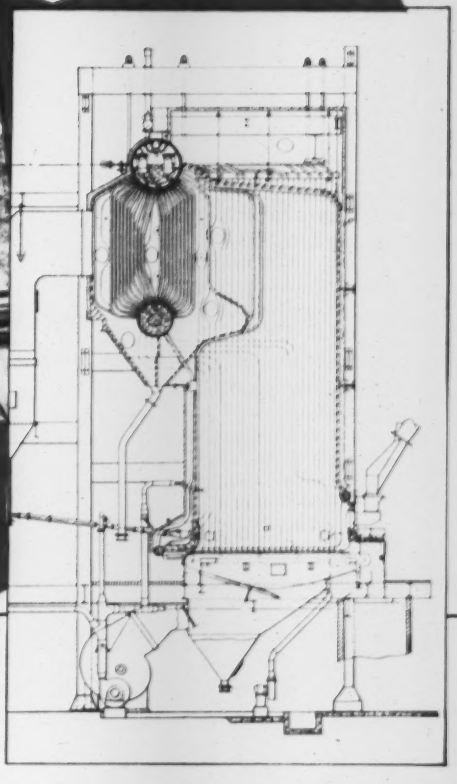
There is a size and type of Detroit Stoker for every industrial need.



Four-elevation traveler Detroit Stoker shows uniform fuel distribution and continuous cleaning feature.

Moundsville, West Virginia, Marshall County Plant, Solvay Process Division, Allied Chemical & Dye Corporation.

Detroit RotoGrate Stoker with Babcock and Wilcox two drum Stirling boilers in Moundsville Plant



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NUCLEAR NEWS FROM ATOMICS INTERNATIONAL

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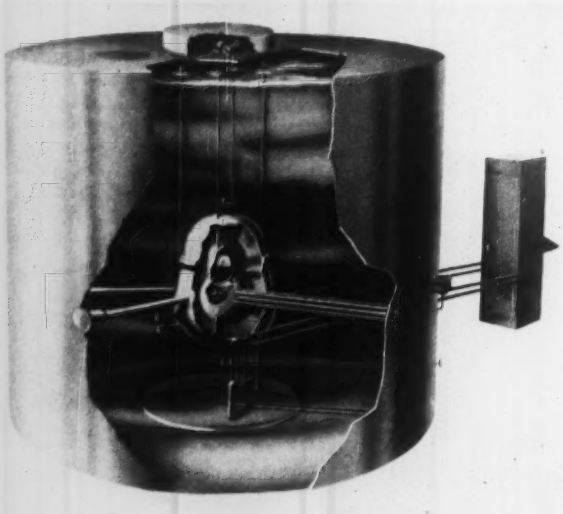
A new atomic tool that will speed and broaden nuclear research and training has been designed and developed by ATOMICS INTERNATIONAL. Here is a low cost instrument that even a moderately-budgeted hospital, industrial or educational laboratory can use to teach and conduct research in nuclear science.



New Laboratory Reactor provides a neutron flux of 10^{11}, a gamma ray flux of 10^{6}.

The Laboratory Reactor (LR) is a 5-watt, solution-type nuclear reactor. It can be operated and maintained by one person. It is 8-feet high, 8-feet in diameter. Power requirements are 110-volts at 60 cycles. It is completely fabricated at the factory and shipped as a unit—manufactured and installed in about 6 months. It has a wide range of applications.

As a laboratory instrument for research programs, the LR permits qualitative analysis by the neutron activation method—including measurement of coatings on metals, moisture testing, and liquid level monitoring. It will produce more than 100 different radioisotopes, about 40 of which have half-lives short enough to eliminate the need for costly contamination controls and waste handling systems.

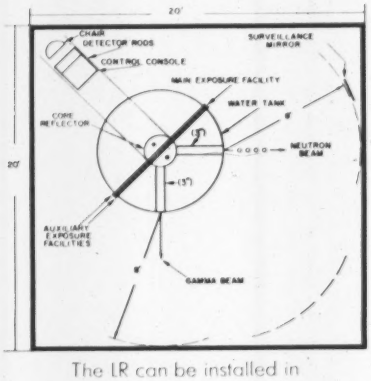
The LR can perform medical research functions such as genetic mutation studies, tracer research on plants and animals, radiation chemistry, and testing by the danger coefficient method. Equipped with facilities to conduct several experiments simultaneously, the reactor is ideally suited as a teaching tool in nuclear engineering, nuclear physics, radiochemistry and radiobiology. The basic behavior of neutron chain reactions, response to control elements, and the effect of delayed neutrons are a few of the 40-odd experiments that can be performed on the Laboratory Reactor.

The core of the reactor is a stainless steel sphere with an overhead convection recombiner. The fuel is uranyl sulphate enriched in uranium 235. The core is enclosed in a 6-inch lead reflector-shield. The complete 3500-pound unit—32" high, 24" wide—is centered in an 8-foot tank filled with water which serves as a biological shield.

The gas recombining system is contained in the core tank. A cylindrical screen above the core solution holds platinized alumina catalyst pellets which recombine hydrogen and oxygen gases formed during reactor operation. These fission product gases—valuable in experimental programs—can be withdrawn from the core through special gas lines.

The LR operator handles all controls and detection equipment from a control console adjacent to the reactor. Two cadmium control rods move vertically through the core—driven by electric motors manually controlled by the operator. The lead-weighted rods are attached to an electromagnet which releases automatically to let the rods fall by gravity into the core and shut down the reactor in event of a scram.

Instrumentation provides safety, low-cost and flexibility. At startup, three boron-lined neutron counters are fully inserted in detection tubes in the water tank. As power level increases, the operator withdraws the counters. Rate circuits—adjusted in response time constants—provide two ¼-second circuit channels for safety and observation and one 2-second channel for accurate power recording.



The LR can be installed in a 20×20-foot floor area.

ATOMICS INTERNATIONAL, a division of North American Aviation, Inc., is a major reactor builder—experienced in the design, construction and operation of nuclear reactors for research and the production of power. If you are interested in the LR—or any phase of reactor development—ATOMICS INTERNATIONAL is staffed and equipped to serve you. Please write, Director of Technical Sales, Dept. ME-71, ATOMICS INTERNATIONAL, P.O. Box 309, Canoga Park, California. Cable address: ATOMICS.

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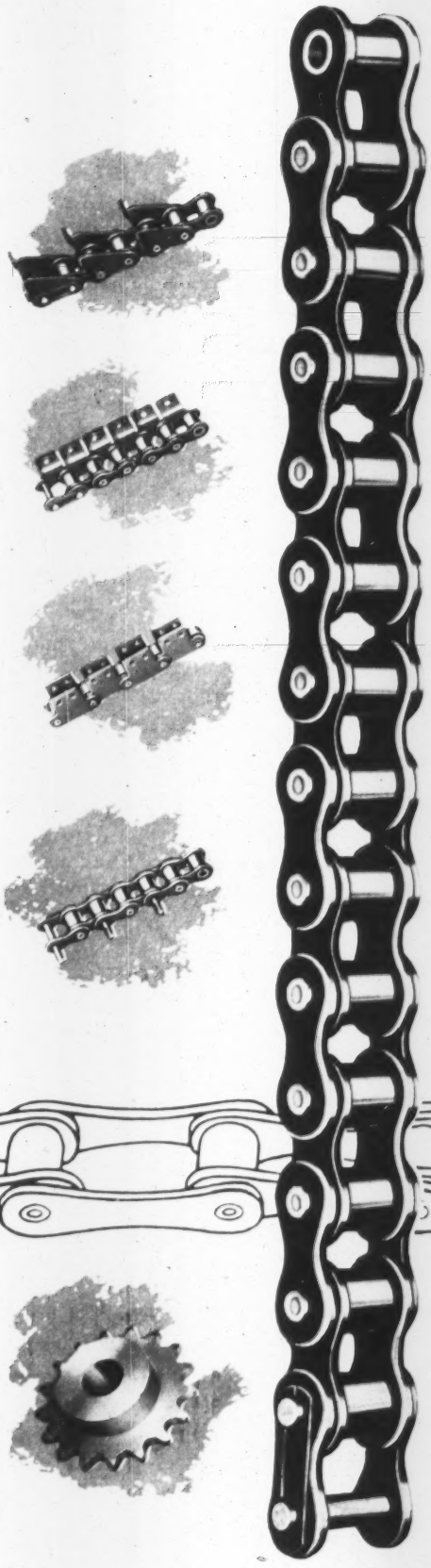

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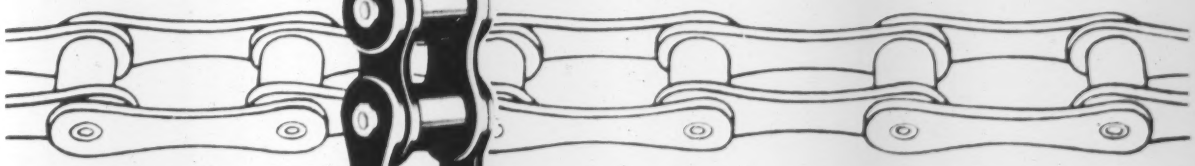

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WILLIAM J. CECKA, JR., 35, aeronautical engineer, (Univ. of Minn. '43), was called from North American by the Air Force for experimental rocket work in 1944. On his return, he progressed rapidly: 1948, supervisory test job; 1950, group engineer, operations; 1953 engineering group leader; 1955, section chief of engineering test. Using our refund plan, he has his M.Sc. in sight.

GEORGE P. SUTTON, in the 13 brilliant years since receiving his MSME, Cal Tech, has made rocketry a way of life. His reputation is world wide. His book *Rocket Propulsion Elements* is recognized as the standard text on the subject. Still active academically, but no bookworm, he takes time off occasionally to study the laws of motion at some of the world's better ski resorts.

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EXACTING RESEARCH, EXCITING PROSPECTS

From the rock-bedded test stands come 2 miles of recordings per day – data far ahead of available texts. The big rocket engine is a flying chemical factory in an absolute state of automation. It tolerates no error. It demands ductwork, turbomachinery, pressure chambers, orifices, injectors, heat exchangers and closed-loop control systems that must put hundreds of pounds of precisely mixed propellants into controlled combustion every second. Tolerances go down to 0.0001". Temperatures range from -250° F to 5000° F. Process time constants occur in "steady state conditions" of the order of a few milliseconds. Event sequences are minutely evaluated, as basis of designed performance predictions of extreme exactitude.

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ROCKWELL BUILT
Edward Valves

Edward Impactor handwheel seats big valve tightly—allows one man to do the job of three.

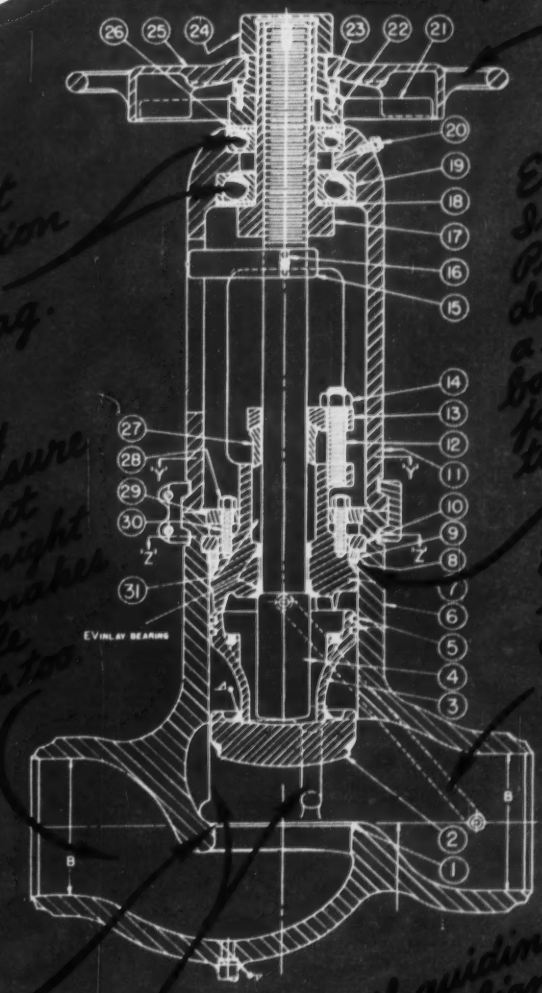
Patented Evalthrust bearing construction eases operation, reduces stem drag.

Streamlined body really helps. Pressure drop is only about half what you might guess. Edward streamlined angle non-return valves too.

Integral Stellite seat is best. Only Edward has it on large valves.

Edward Improved Pressure Seal bonnet design makes a leak proof joint, is easy to disassemble.

Equalizer aids disk-piston lift, reduces motion and extends life of guiding surfaces.



Full length rib guiding of disk provides perfect alignment, insures true seating and reduces danger of hang ups.

When it comes to steel non-return valves, let's order Edward and have them quote on other valves too.

LIST OF MATERIALS
QUANTITIES ARE FOR ONE VALVE
WHERE A NUMBER APPEARS UNDER SPECIFICATIONS, IT INDICATES THE LATEST REVISION APPLIES

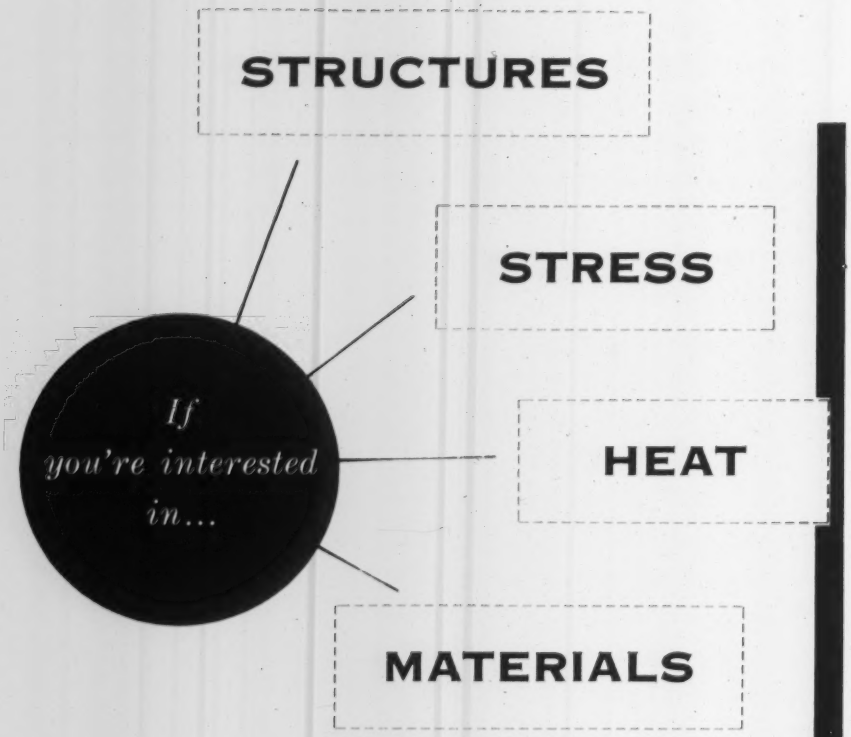
PIECE	NAME OF PIECE	QUAN.	MATERIAL	SPECIFICATIONS	APPROX. WEIGHT
1	SEAT	1	STELLITE	INTEGRAL WITH BODY	8.5
2	DISH	1	FORGED ALLOY STEEL	A.S.T.M. A182, GRADE F11	2.5
			STELLITED		4.0
3	PISTON RING (LOCKED TO DISH)	1	CAST IRON	A.S.T.M. A126, CLASS B	1.0
4	SEAT	1	CAST IRON	A.S.T.M. A126, CLASS B	7.0
5	PISTON RINGS	2	CAST IRON	A.S.T.M. A126, CLASS B	1.0
			CAST STEEL	A.S.T.M. A216, GRADE WCB	9.0
6	BODY	1	CAST STEEL	A.S.T.M. A216, GRADE WCA	9.0
			CAST STEEL	A.S.T.M. A352, GRADE LCB	9.0
7	BONNET	1	CAST STEEL	A.S.T.M. A216, GRADE WCB	3.0
8	PRESSURE SEAL GASKET	1	STAINLESS IRON		0.2
9	PACKING RING	1	CAST IRON	A.S.T.M. A126, CLASS B	0.1
10	PACKING RING	1	CAST IRON	A.S.T.M. A126, CLASS B	0.1
11	PACKING RING	1	CAST IRON	A.S.T.M. A126, CLASS B	0.1
12	PACKING RING	1	CAST IRON	A.S.T.M. A126, CLASS B	0.1
13	PACKING RING	1	CAST IRON	A.S.T.M. A126, CLASS B	0.1
14	PACKING RING	1	CAST IRON	A.S.T.M. A126, CLASS B	0.1
15	YOKE	1	CAST STEEL	A.S.T.M. A216, GRADE WCB	7.0
16	YOKE BUSHING	1	CAST BRONZE	A.S.T.M. B62	0.2
17	HANDWHEEL	1	CAST IRON	A.S.T.M. A126, CLASS B	2.5
18	HANDWHEEL NUT	1	STEEL		0.1
19	STEM	1	FORGED ALLOY STEEL	A.S.T.M. A182, GRADE F6a	1.5
20	THRUST BEARING	1	STEEL WITH INDUSTRIAL DIAMOND		0.1
21	THRUST BEARING	1	STEEL		0.1
22	THRUST BEARING	1	STEEL		0.1
23	THRUST BEARING	1	STEEL		0.1
24	GLAND	1	CAST STEEL	A.S.T.M. A216, GRADE WCB	0.5
25	GLAND BUSHING	1	CAST STEEL	A.S.T.M. A216, GRADE WCB	0.5
26	GLAND BOLT	2	STEEL		0.1
27	PACKING RINGS		HIGH TEMPERATURE PACKING		

Edward builds Globe and Angle Stop, Non-Return, Check, Stop-Check, Gate, Blow-Off, Mudline, Relief, Hydraulic, Instrument, Gage, and Special Valves and Strainers.

EDWARD VALVES, INC.
SUBSIDIARY OF ROCKWELL MANUFACTURING CO.
EAST CHICAGO, INDIANA

EDWARD GLOBE NON-RETURN VALVE
PRESSURE SEAL BONNET — WELDING ENDS
GENERAL ASSEMBLY

DRAWN [illegible] | DRAWING NO. AE-3213-6
CHK'D O. Peter
APP'D [illegible] DATE [illegible]



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To participate in the design and development of missiles, missile launchers, aircraft structure, component installation, environmental test equipment, hydraulic and general mechanical design.

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E. B. J.

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Edward Valves

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Swivel disk and radiused stem end prevent galling insure perfect seating

Edward integral Stellited seat and Stellited disk cut repairs sharply.

Straight through flow minimizes turbulence and pressure drop.

All forged construction reduces bulk—eliminates porosity.

We'll be better off using Edward forged valves for all small piping on our job. Let's get a bid.

LIST OF MATERIAL
QUANTITIES ARE FOR 1 GLOBE OR 1 ANGLE VALVE
WHERE A.S.T.M. SPECIFICATIONS ARE INDICATED THE LATEST REVISION APPLIES

PIECE NO.	NAME OF PIECE	NO. REQ'D	MATERIAL	SPECIFICATIONS	EDWARD MS NO.
1	DISK	1	FORGED ALLOY	A.S.T.M. A182, GRADE F11	227
			STEEL, STELLITED		483
2	DISK NUT	1	STEEL	A.I.S.I. C1020	123
3	BODY	1	FORGED STEEL (a)	A.S.T.M. A105, GRADE II	111/483
			FORGED STEEL (b)	A.S.T.M. A182, GRADE F11	227/483
4	BONNET	1	FORGED STEEL (a)	A.S.T.M. A105, GRADE II	111
			FORGED STEEL (b)	A.S.T.M. A182, GRADE F11	227
5	GLAND	1	MALLEABLE IRON	A.S.T.M. A220, GRADE 45005	324
6	STEM	1	ALLOY	A.I.S.I. GRADE 416	281
7	HANDWHEEL	1	MALLEABLE IRON	A.S.T.M. A47, GRADE 32510	322
8	STEM NUT	1	STEEL	A.S.T.M. A108 - GRADE 1	124
9	YOKE BUSHING	1	BRONZE	A.S.T.M. B62	217
10	PACKING RINGS	1	ASBESTOS	HIGH TEMPERATURE PACKING	501
11	JUNK RING	1	STEEL (PLATED)	A.I.S.I. C1020	123
12	BONNET GASKET	1	EVALPAK		505
13	GLAND BOLT WASHER	2	STEEL		
14	GLAND BOLT	2	FORGED STEEL (VALVE TYPE)	A.S.T.M. A105, GRADE II	111
15	GLAND BOLT NUT	2	STEEL (PLATED)	A.S.T.M. A194 - GRADE 0	129
16	TAP END STUD	4	ALLOY STEEL (c)	A.S.T.M. A193	
17	BONNET STUD NUT	4	STEEL (c)	A.S.T.M. A194 -	

EDWARD VALVES, INC.
SUBSIDIARY OF ROCKWELL MANUFACTURING CO.
EAST CHICAGO, INDIANA

FORGED STEEL
GLOBE AND ANGLE VALVES

DRAWN		DRAWING NO
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APP'D	DATE	

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Inside Story on POWELL VALVES for POWER PLANTS

On the outside, valves may look alike. However, on the inside there can be a big difference -- in the metal itself, in design, in manufacture. And the inside story on Powell Valves for Power Plants is that every valve has PERFORMANCE VERIFIED.

In the manufacture of Powell Valves, only the finest available materials are used. And painstaking quality control is rigidly enforced through each and every step of manufacture. Every part of every valve must pass rigid inspection.

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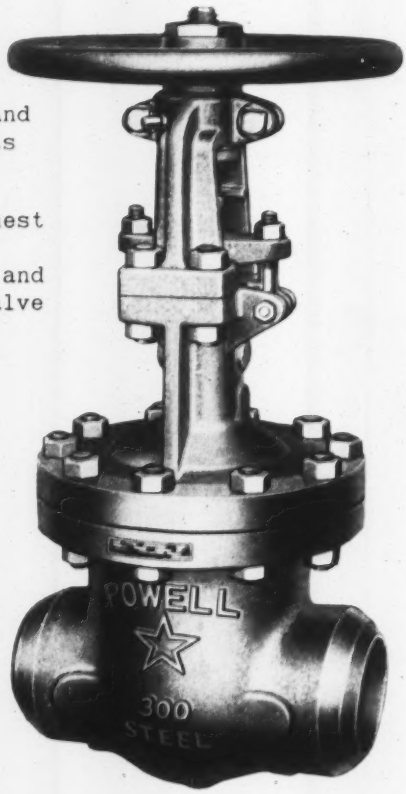

FIG. 3003WE -- Steel O.S. and Y. Gate Valve for 300 Pounds W.S.P.

FIG. 1561WE -- 150-Pound Steel Swing Check Valve

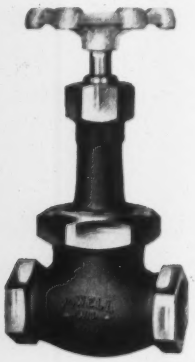

FIG. 2608 -- Bronze "W.S." Full Flow Globe Valve for 200 Pounds W.P.

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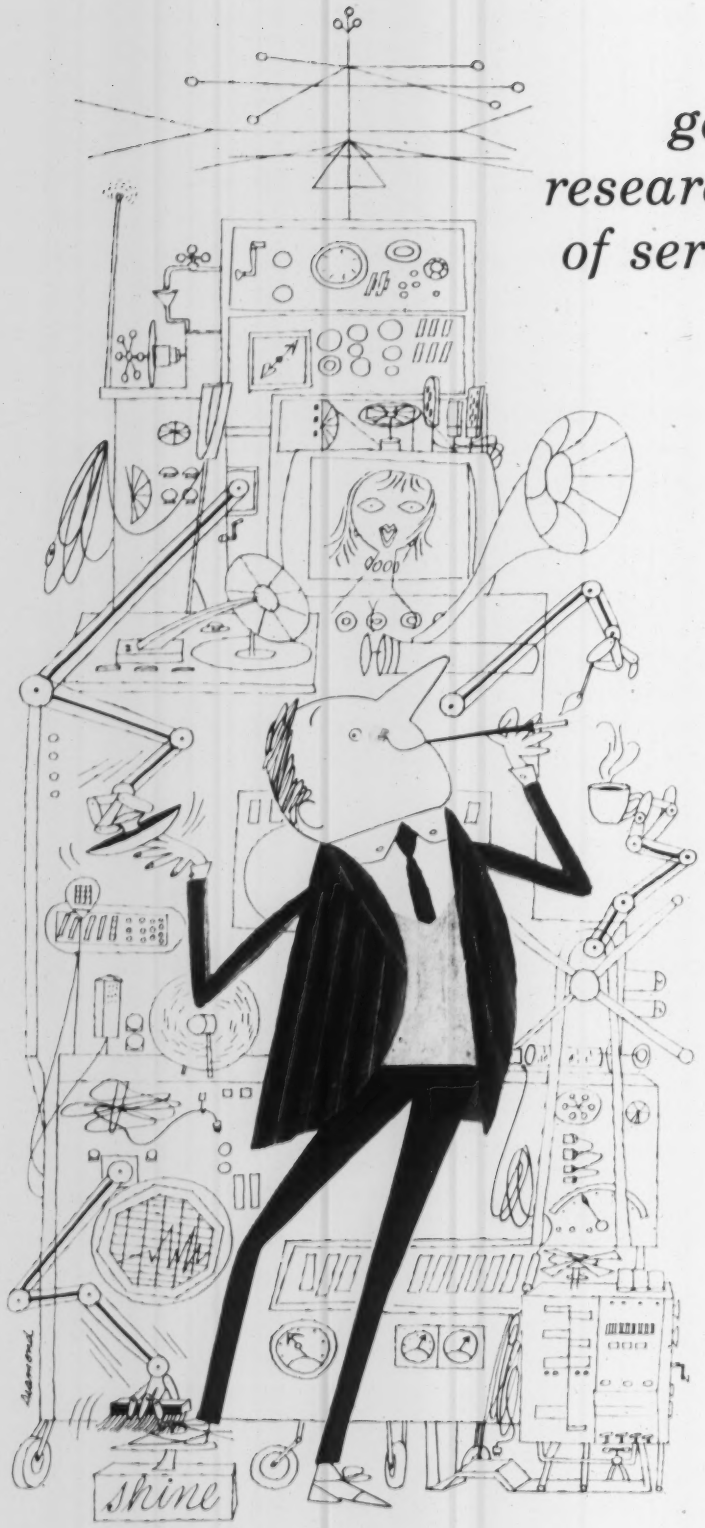

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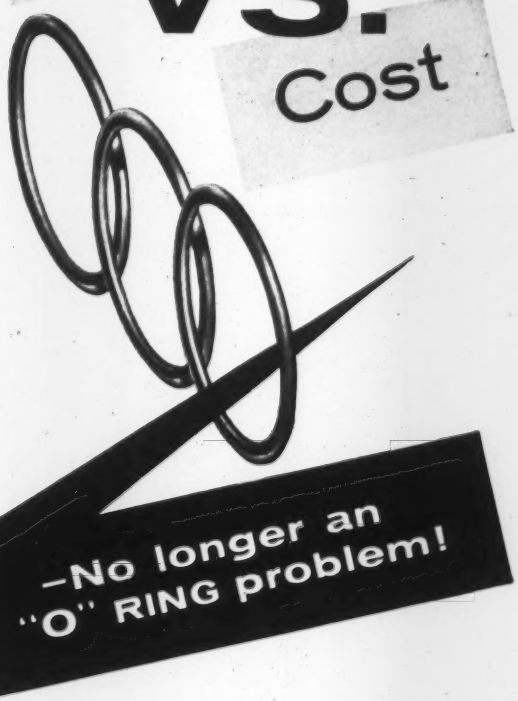

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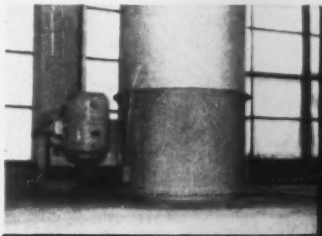
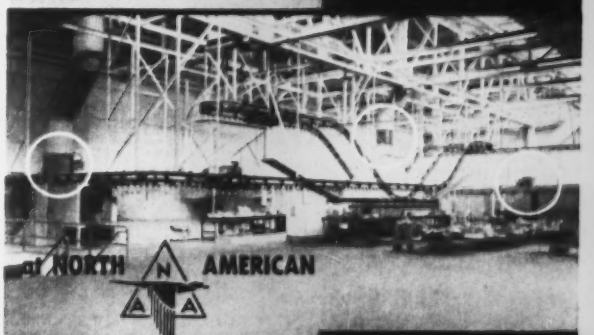


"giving acid fumes the air..."



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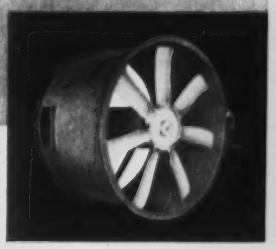

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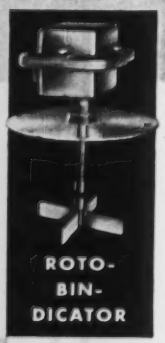

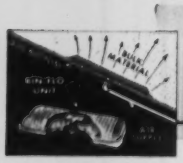

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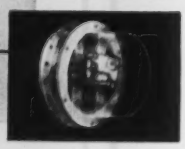
BIN-FLO AERATOR



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Applies to spur, helical, bevel, and hypoid gears. The diameters considered are from ¾ to 100 inches. The pitches range from 1 to 32 diametral pitch. Allowances and tolerances for backlash are also treated.

20-DEGREE INVOLUTE FINE-PITCH SYSTEM FOR SPUR AND HELICAL GEARS, B6.7—1956. $1.50

Presents tooth proportions, dimensions of gears and enlarged pinions, tolerances on outside diameter of gears, design data for spur and helical pinions having 9, 8, and 7 teeth, formulas for calculating the values of the various tables, and terminology. To this revision has been added a format for putting of spur and helical gear dimensions on drawings.

FINE-PITCH STRAIGHT BEVEL GEARS, B6.8—1950. $1.00

Covering generated straight bevel gears of 20 diametral pitch and finer, this Standard gives the gear dimensions, the tooth proportions for 1- diameter pitch, general specifications, dimensions and tolerances for gear blanks, nomenclature, and symbols.

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A design procedure for worms and worm gears with axes at right angles, this Standard gives the proportions of worms and worm gears, values of diameter for all possible combinations of leads and lead angles within the Standard, tooth proportions based on normal pitch for all combinations of standard axial pitches and lead angles, and an extensive table of profile deviations and pressure angle changes. Added to this 1956 revision are: an appendix which explains and illustrates profile deviation in worm threads, and a separate section covering gear blanks.

INSPECTION OF FINE-PITCH GEARS, B6.11—1956. $2.50

Outlines methods for determining gear quality; recommends the tolerances for gears and various gear blank elements; specifies the backlash in gears; gives recommendations for machining gear blanks, the pin measurements for spur gears and procedures for making comparator layouts to check gear and worm profiles; includes directions for using master jaws; classifications for various degrees of surface roughness, waviness and lay; and symbols for use on drawings. This revision contains a new table giving the settings for a variable center distance gage for the diverse combinations of total composite errors and tooth thickness reduction, a new section on backlash, and the latest rack and similar devices.

A SYSTEM FOR STRAIGHT BEVEL GEARS, B6.13—1955. $1.00

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NOMENCLATURE FOR GEAR TOOTH WEAR AND FAILURE, B6.12—1954. $1.50

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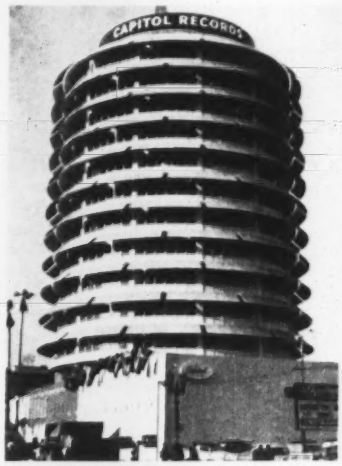

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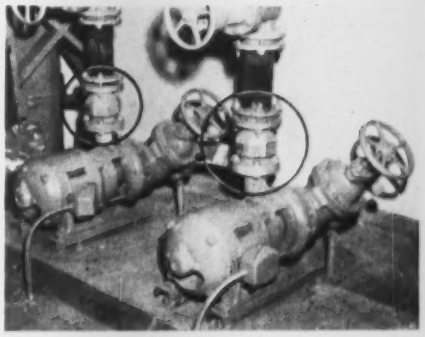

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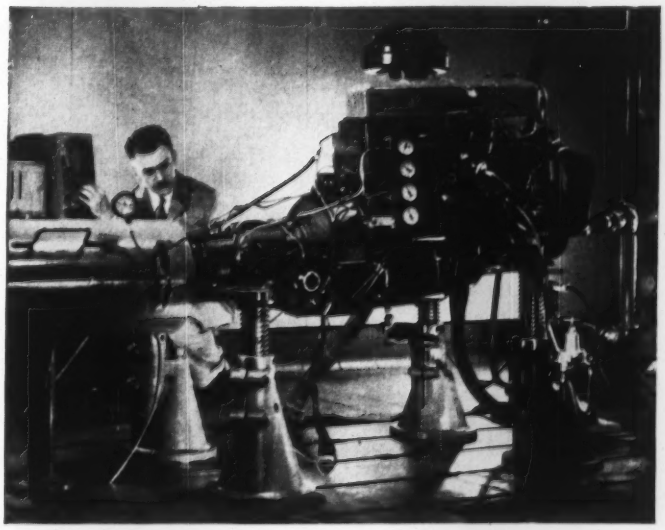

In this dynamometer test, an automobile engine is supported by Lake Shore engine jacks. These versatile jacks have a 360 degree eccentric swing and are quickly adjustable and locked in position. With these engine jacks bolted to a precision-made Lake Shore dynamometer base, you get greater mounting flexibility and more accurate testing control.

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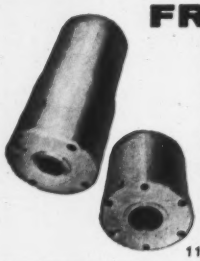

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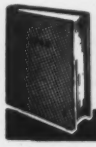

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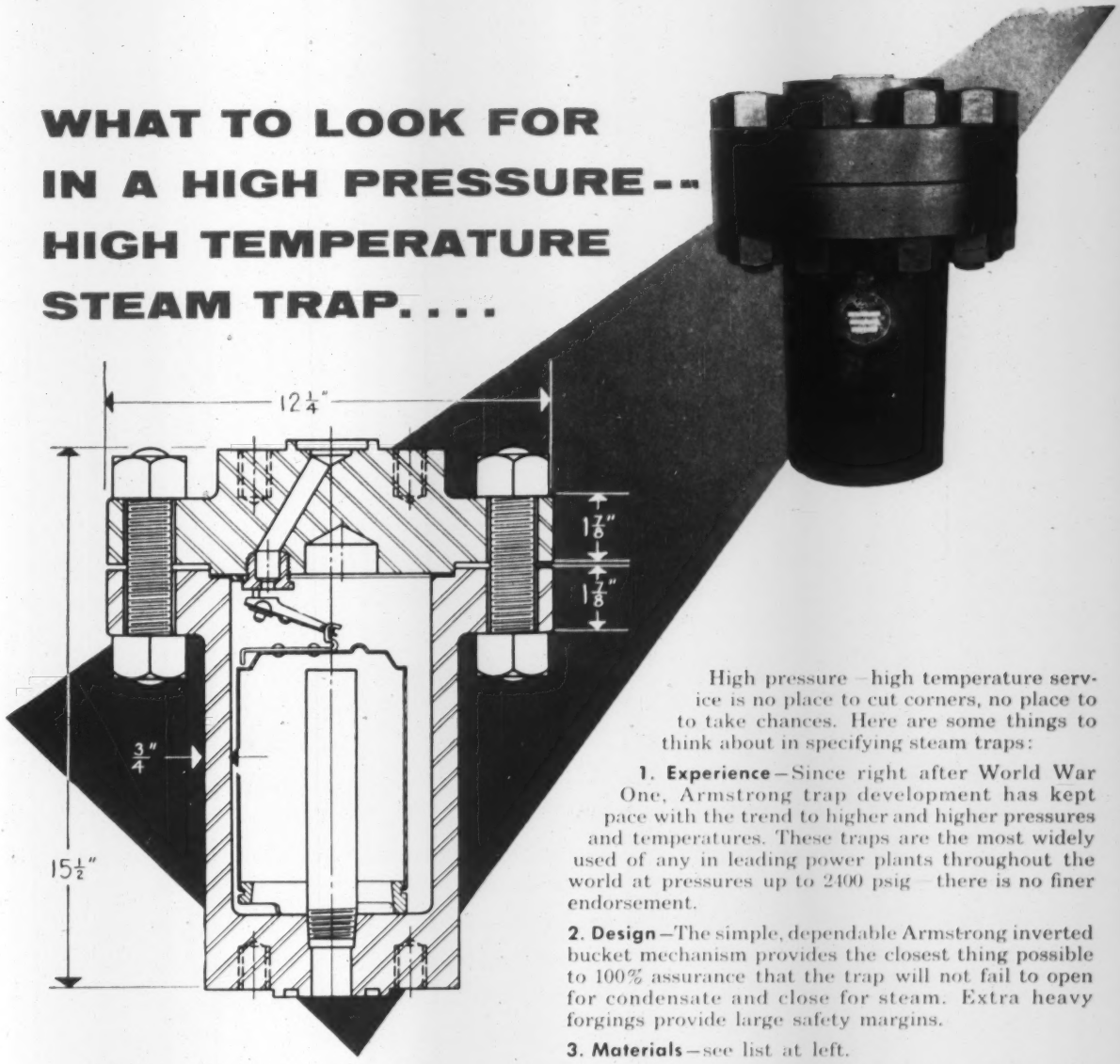

LIST OF MATERIALS

ARMSTRONG FORGED STEEL TRAPS

Part	Material
CAP AND BODY FORGINGS	
Up to 600 psi, 750°	1030 carbon steel
Up to 900 psi, 900°	ASTM Spec. F-1 carbon moly steel
Up to 2500 psi, above 900°	ASTM Spec F-5 chrome moly steel
VALVE AND SEAT	Type 440 chrome steel, heat treated, standard. Stellite available.
LEVER MECHANISM	Stainless steel
BUCKET	Stainless steel
BOLTS	Class C high tensile, high temperature bolting material—125,000 min. tensile.
NUTS	Hex, semi-finish, heat treated for high pressure, high temperature service.
GASKET	Compressed graphited asbestos
INLET TUBE	Wrought iron

High pressure—high temperature service is no place to cut corners, no place to to take chances. Here are some things to think about in specifying steam traps:

1. Experience—Since right after World War One, Armstrong trap development has kept pace with the trend to higher and higher pressures and temperatures. These traps are the most widely used of any in leading power plants throughout the world at pressures up to 2400 psig—there is no finer endorsement.

2. Design—The simple, dependable Armstrong inverted bucket mechanism provides the closest thing possible to 100% assurance that the trap will not fail to open for condensate and close for steam. Extra heavy forgings provide large safety margins.

3. Materials—see list at left.

4. Price—Armstrong forged steel trap list prices range from $95 to over $1000. The No. 515 shown above is rated for 1500 psig at 900°F and for 2000 psig at 600°F. It lists at $500. Armstrong prices are moderate for what you get because of high production. *There is no compromise made at the expense of safety, quality and low maintenance.*

Want more facts?—Call your local Armstrong Representative or write: Armstrong Machine Works, 812 Maple Street, Three Rivers, Michigan.

Do you have Catalog J?—This 44-page Steam Trap Book is free on request.

ARMSTRONG MACHINE WORKS
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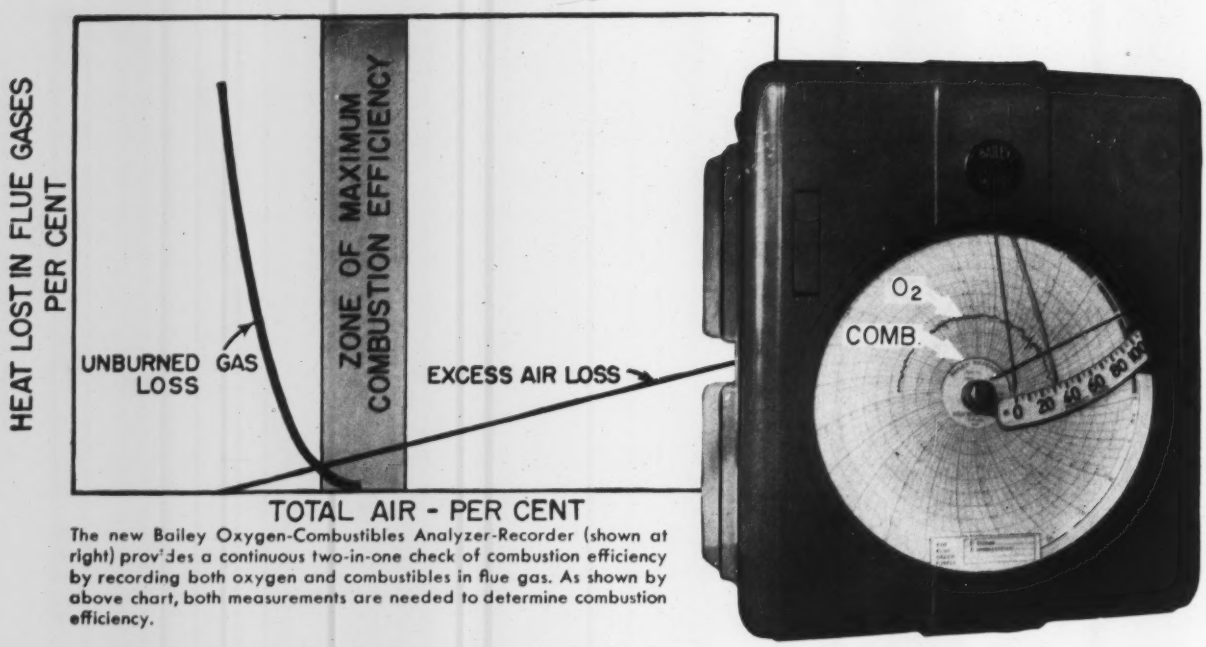
STEAM TRAPS FOR EVERY REQUIREMENT — APPLICATION ENGINEERED

ARMSTRONG STEAM TRAPS



The new Bailey Oxygen-Combustibles Analyzer-Recorder (shown at right) provides a continuous two-in-one check of combustion efficiency by recording both oxygen and combustibles in flue gas. As shown by above chart, both measurements are needed to determine combustion efficiency.

BAILEY announces . . . New 2 in 1 way to measure Combustion Efficiency

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1. Excess air—regardless of the fuel or combinations of fuels being burned.

2. The mixing efficiency of your fuel-burning equipment—by indicating the amount of combustibles in your flue gas, resulting from incomplete mixing of fuel and air.

Combustion efficiency depends upon fuel-air ratio. Too much fuel can be even more costly than too much air. And because of the interdependence of these two factors, no control that measures only one of them can give you complete protection.

Now, for the first time, you can check *both* with a *single* fast acting instrument, using the new Bailey Oxygen-Combustibles Analyzer-Recorder for industrial furnaces, kilns, heaters and boilers.

Fuel economy improves as excess air is reduced —until unburned fuel begins to show up in the flue gas. When this happens, combustion efficiency drops off sharply if there are further decreases in the air-fuel ratio. That's why combustion gases must be analyzed for *both* oxygen and combustibles to get a true indication of efficiency—and that is why Bailey coordinates both measurements on the same chart, to show when excess air may be reduced safely without danger of greater losses from unburned gases.

The Bailey Oxygen-Combustibles Analyzer is an approved combustion safeguard.

Ask your local Bailey engineer for suggestions on application. Equipment details in Product Specifications E65-1 and E12-5. P31-1

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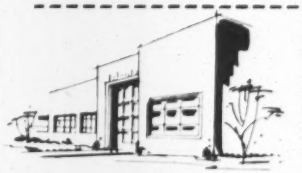

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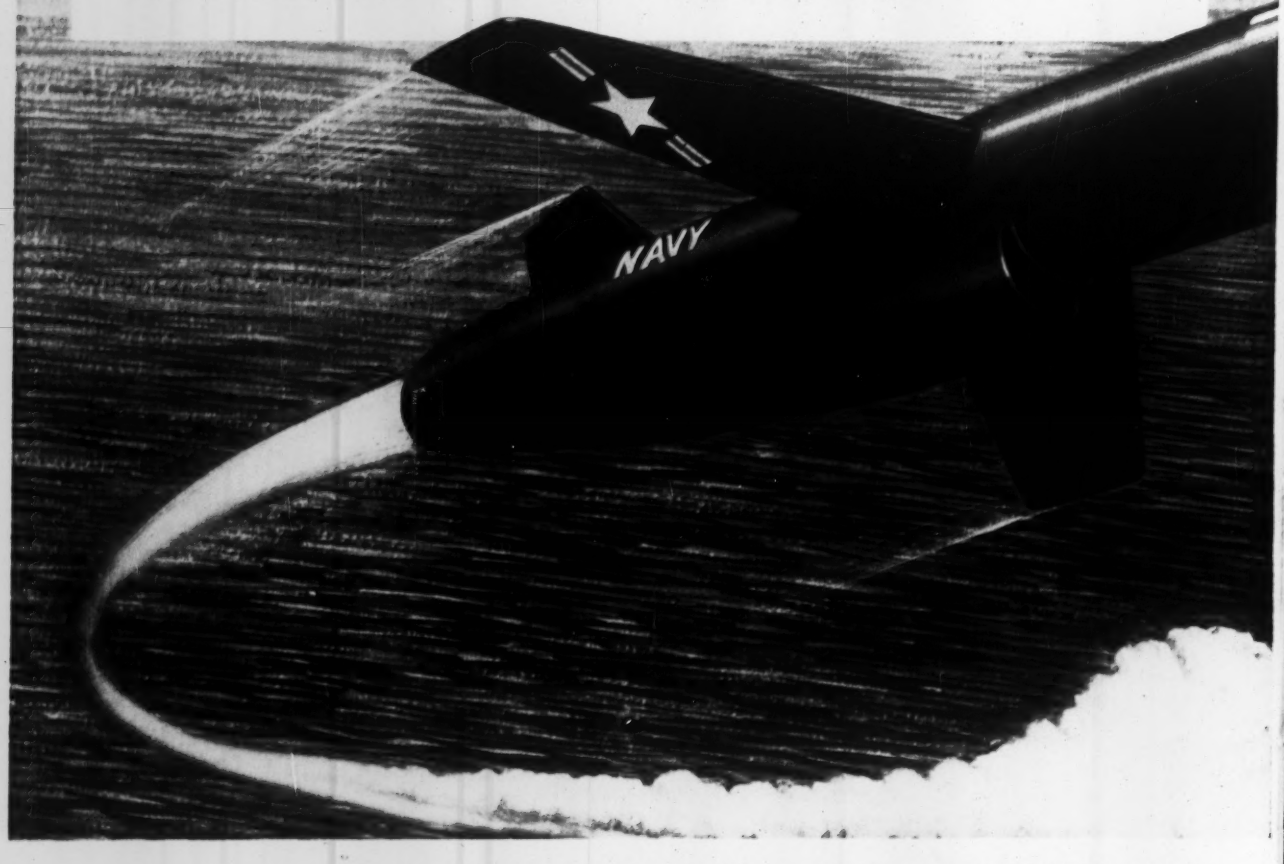

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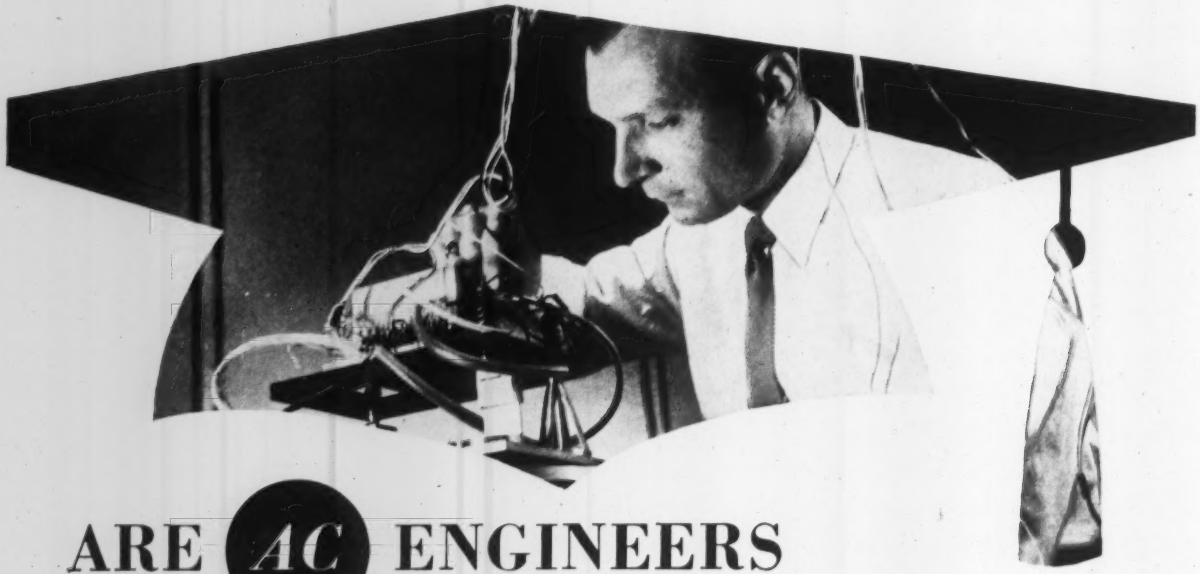

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AC THE ELECTRONICS DIVISION
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Comprehensive and varied training programs to develop both technical and administrative abilities.

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Mr. T. J. Donovan
Engineering Department

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One thing you *won't* get at Chrysler Engineering is a lot of wild claims and gold-plated promises. We won't even tell you that Chrysler Engineering is the best place to work. But we do have many fine advantages in *automotive* research and development that you, as a creative engineer, will find mighty interesting. For example—

Creative assignments. Flexibility and freedom in the work you do. The opportunity to make your own decisions. Good pay. Fellow employees and superiors who are easy to work with. Very good advancement opportunities, including extra rewards for ambition and accomplishment. The opportunity to increase your knowledge at the famed Chrysler Institute of Engineering. And you can add to your experience by working with people who are authorities in the field.

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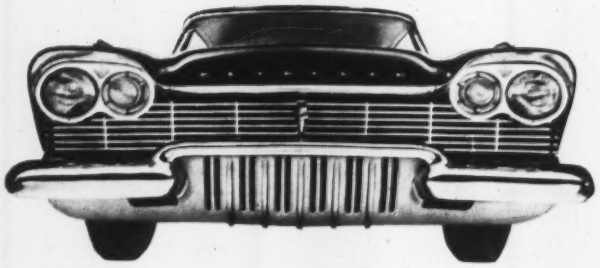

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Work consists of translating process requirements into completed operating pilot plants and includes mechanical design, proper application of equipment, instrumentation, cost estimation, scheduling, materials procurement, field supervision of construction, initial operating shake-down, and new equipment development.

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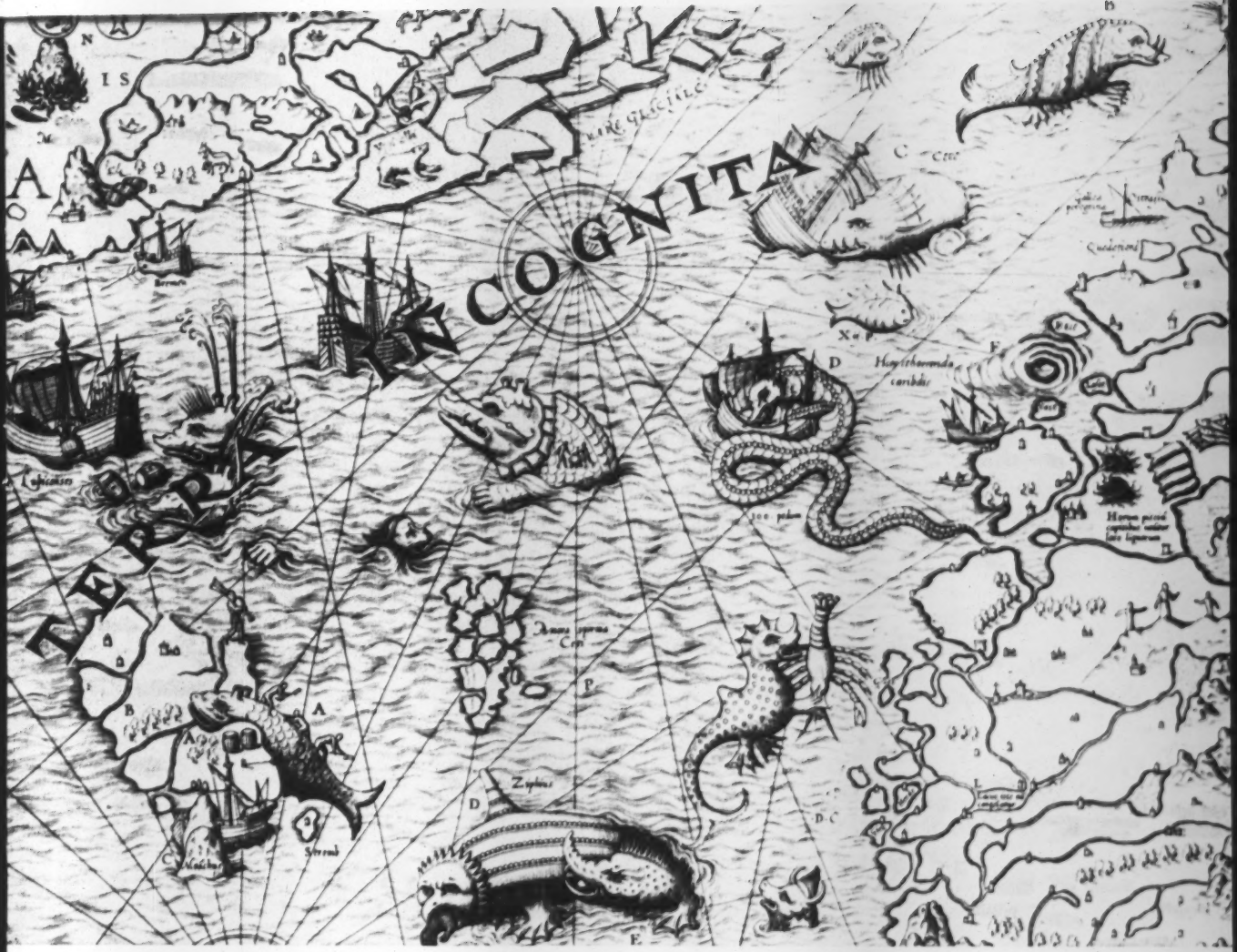
(Chief Technical Subsidiary—Standard Oil Company (New Jersey))
Esso Research Center
Employee Relations—C
P. O. Box 51 **Linden, N. J.**



An UNKNOWN WORLD Awaits Us, Too

TERRA INCOGNITA – the Unknown World. This was the challenge to men of earlier centuries . . . to venture into the mysterious, unexplored regions of the Earth. They met the challenge and found new lands.

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another example of exciting work at los alamos...

PREPARATION OF RaLa SOURCES

Since 1944 the Los Alamos Scientific Laboratory has pioneered in the study of the effects of intense radiation on chemical, biological and radiographic systems. Among energy sources for such experimentation are extremely small, high-intensity gamma ray emitters containing radioactive lanthanum-140. Known as RaLa, these sources range up to 10,000 curies (370 million million disintegrations per second, equivalent to several times the known amount of the world's extracted radium).

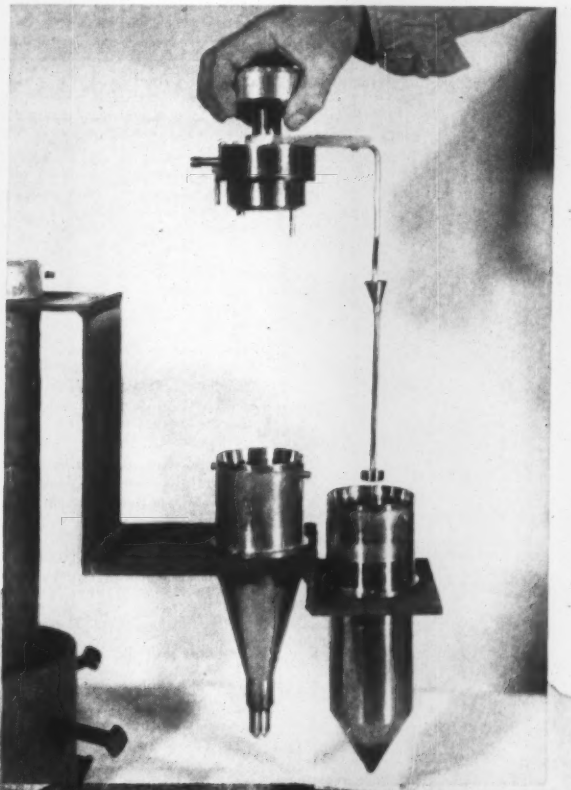
Obviously, preparation of RaLa sources is done entirely with remote-handling equipment largely controlled with pushbuttons and actuated through servo-mechanisms. Design and much of the fabrication of the handling apparatus are also Los Alamos accomplishments and the Laboratory facility is one of the most highly developed in the United States.

Scientists and engineers interested in these or other projects at Los Alamos Scientific Laboratory are invited to write to:

Director of Scientific Personnel
Division 1707

los alamos
scientific laboratory
OF THE UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO

Operator at the control console of the RaLa processing laboratory. The apparatus shown at the right is seen through the periscope.

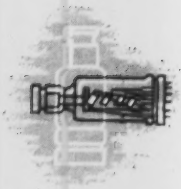


The apparatus to the left is used for precise alignment of the filtering assembly used in hot cells for RaLa processing. When in actual use it is operated by remote control.

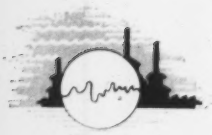
Los Alamos Scientific Laboratory is a non-civil service operation of the University of California for the U. S. Atomic Energy Commission.

This drawing shows the remotely controlled equipment for chemical separation, filtering, drying, pelleting, and jacketing of RaLa sources. Up to 100,000 curies can be handled.

MISSILES



SPECIAL PURPOSE TUBES



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Technical Employment Director

FARNSWORTH ELECTRONICS COMPANY
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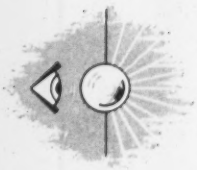
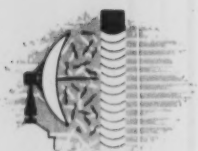
SOLID STATE AND APPLIED PHYSICS

PRODUCT ENGINEERING



INFRA-RED

PRODUCTION



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We need a man capable of analyzing highly complex electronic equipment for the purpose of achieving lower cost while maintaining function.

He must be a diplomat . . . the philosophy and techniques of Value Analysis must be "sold" to our design men.

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BOX 6060

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P. O. box 1311
Texas City, Texas

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WHERE do you start training for promotion from your first day on the job?

For the answer, turn to page 165

It will pay you to watch the announcements on these pages for an opportunity that you may be looking for or one that may be of interest to you.

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MONROEVILLE, PENNSYLVANIA

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inertial

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Position Responsibilities: Technical direction and functional leadership of six to ten engineers in the design, development and evaluation of inertial systems, such as gyros, accelerometers, velocimeters, and odometers, as applied to arming and fuzing of missile systems.

Position Requirements: BS or MS in Mechanical Engineering, Electrical Engineering, or Physics; five to ten years' experience in design, development, and evaluation of inertial electromechanical components and systems, preferably for missile or related applications.

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Please send resume in confidence to:
Mr. John Watt

Technical Recruiting, Room 565-1

Missile & Ordnance Systems Dept.

GENERAL ELECTRIC

3198 Chestnut Street
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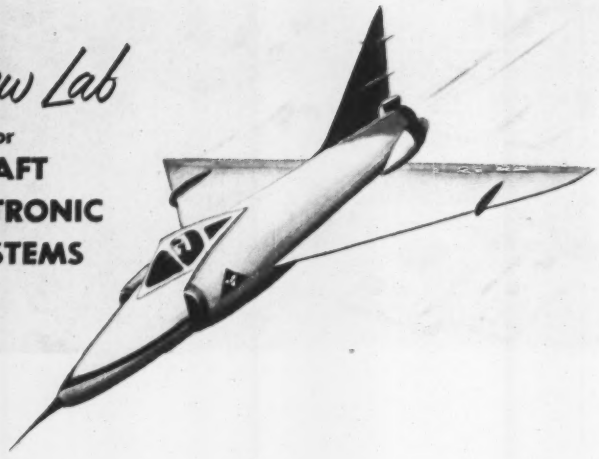
A New Lab for AIRCRAFT ELECTRONIC SYSTEMS



The recently formed MAYNARD LABORATORY has a nucleus of some of the country's finest engineers designing and developing advanced coherent radar systems used in the navigation and guidance of supersonic aircraft.

The application of ELECTRONICS to the needs of the rapidly expanding AIRCRAFT INDUSTRY provides unmatched opportunities for the engineer who wants challenging, interesting work with prospects of real progress.

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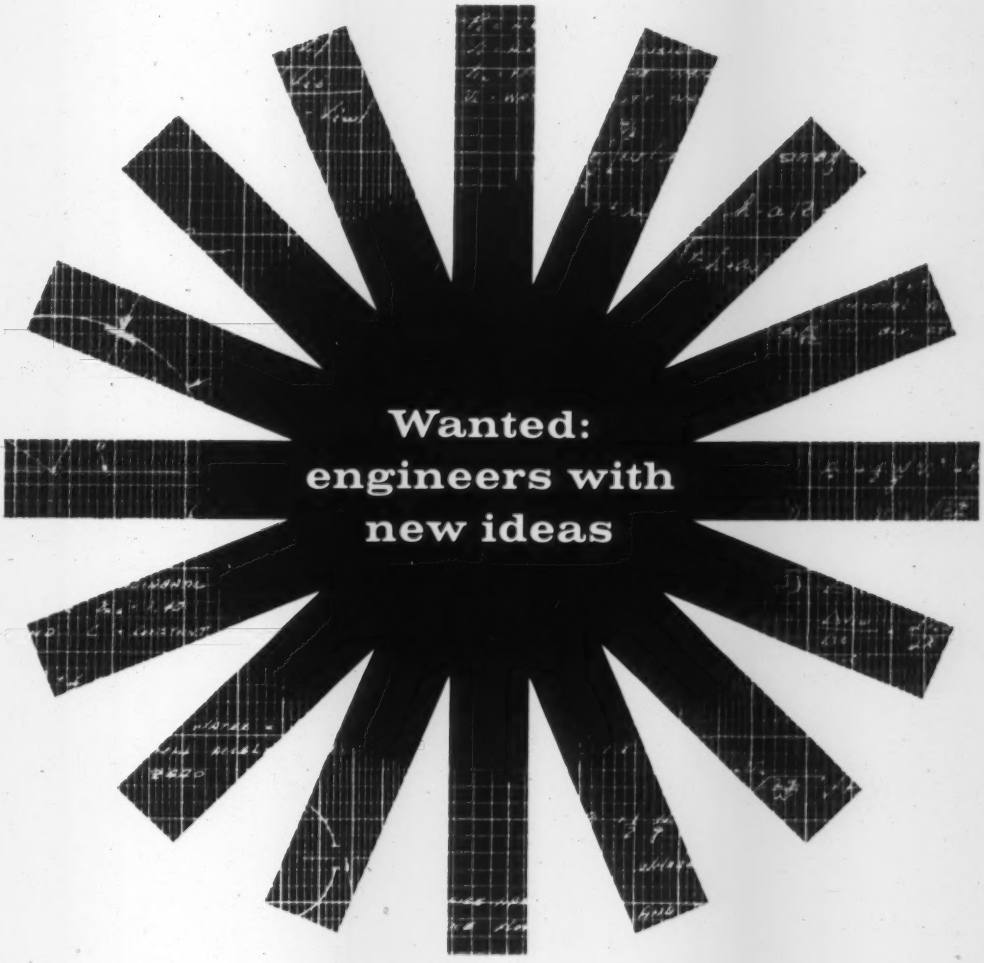

The California Division of Lockheed has a special problem. It doesn't limit itself to a few types of planes. It develops virtually all types – cargo and commercial transports, extremely high-speed fighters, radar search planes, jet trainers, patrol bombers and others still classified. And it takes a constant flow of new engineering ideas to feed this ever-expanding program.

Do you have new ideas? They'll get attention at Lockheed. Your future relationship with us is certainly worth exploring. Openings are in virtually every field of engineering. Perhaps the most convenient method for you to contact us is to write E. W. Des Lauriers, Manager, Professional Recruiting, or send in the brief résumé form below.

California Division

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Aircraft Corporation, Burbank, California

P. S. Aircraft experience is not necessary to join Lockheed. It's your engineering training, experience and ability that count.

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If you are an engineer, please state your field of engineering

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The assignments are stimulating, and on advanced levels.

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You'll have the best facilities in the field at your disposal, and gain from the experience of the men who developed the famed T-58—with its "Constant Speed Control"—new concept that threatens to revolutionize helicopter design. Advancement is rapid. Benefits are comprehensive. And you'll enjoy living within ten miles of Boston—cultural center for all New England.

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for

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Technical Recruiting — Room 525-14

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are offered opportunity to advance professionally in diversified growth company

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Openings exist for all levels of experience. Training and rotation are provided. High salaries are combined with a profit sharing and bonus program. Professional development is encouraged—growth is continually creating new managerial positions.

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Needs
MECHANICAL ENGINEERS
and
CHEMICAL ENGINEERS

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Responsibilities include the analysis of data, assignment and interpretation of sampling plans, training, evaluation of inspection effectiveness and product quality. Applicants must have a degree in Mathematics, or in Mechanical or Electrical Engineering.

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Staff Employment Section 553
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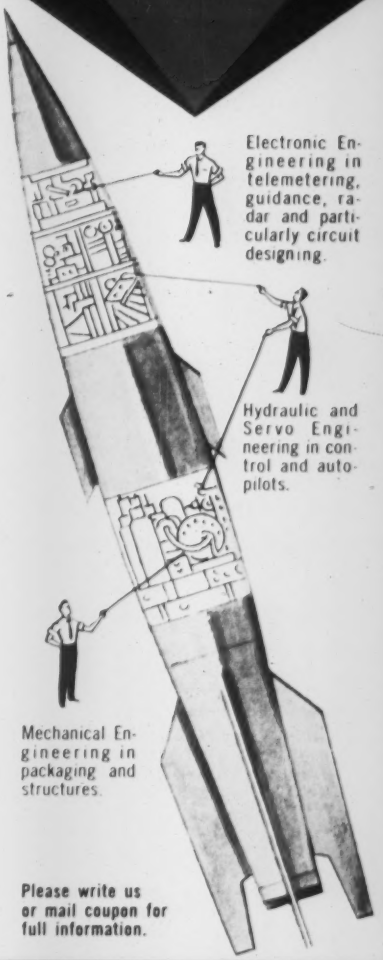

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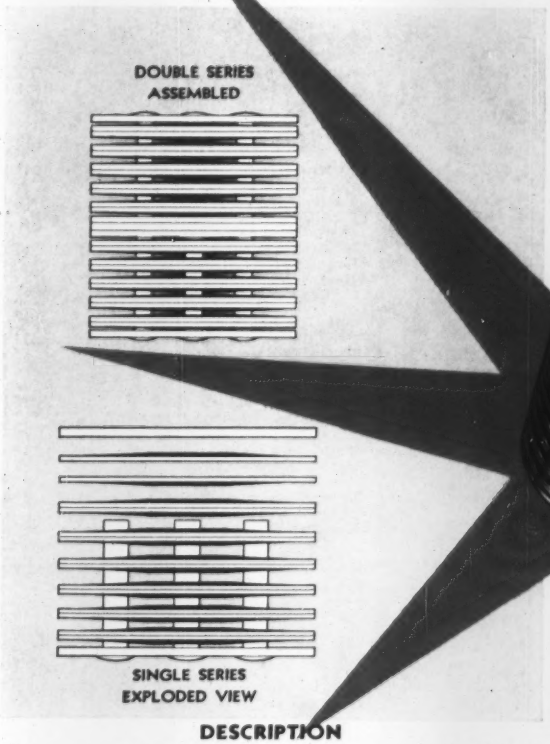

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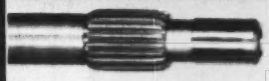
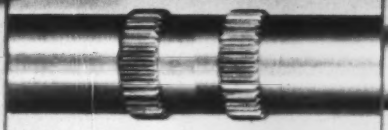


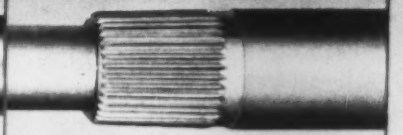
20 teeth
24/36 DP

30 deg PA
SAE 5140 H

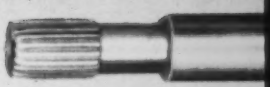


37 teeth
24/48 DP

45 deg PA
SAE 1037



1-3/4" x 36 tapered serrations
SAE 1040

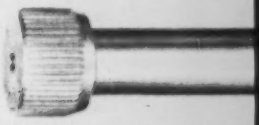


20 teeth
24/48 DP

30 deg PA
SAE 1024

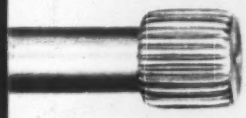
20 teeth
24/36 DP

30 deg PA
410 stainless steel



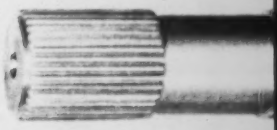
50 teeth
32/64 DP

45 deg PA
SAE 8660



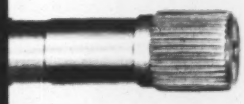
28 teeth
20/40 DP

30 deg PA
Machine steel



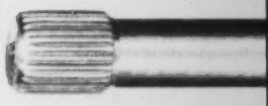
37 teeth
24/48 DP

45 deg PA
SAE 1330



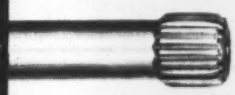
37 teeth
32/64 DP

45 deg PA
SAE 1037



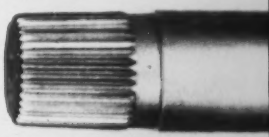
28 teeth
24/48 DP

45 deg PA
ASTM-B-16 brass



20 teeth
20/30 DP

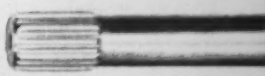
30 deg PA
SAE 4340



1-3/4" x 36 tapered serration
SAE 1040

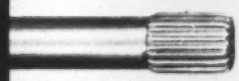
14 teeth
24/48 DP

30 deg PA
Nitralloy



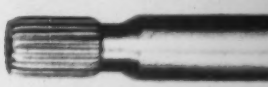
20 teeth
24/36 DP

30 deg PA
24S-T4 aluminum



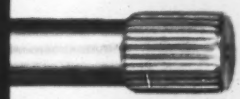
20 teeth
24/36 DP

30 deg PA
SAE 1037



20 teeth
24/48 DP

45 deg PA
SAE 1037



20 teeth
24/36 DP

30 deg PA
303 stainless steel

13 teeth
20/40 DP

25 deg HA
30 deg PA
SAE 1037

13 teeth
20/40 DP
25 deg HA

30 deg PA
SAE 1037

Note: Roll spline to shoulder

20 teeth
24/36 DP

30 deg PA
SAE 4130

Note: Roll spline to shoulder

ROTO-FLO formed parts are produced faster, at lower cost, are stronger than machined parts of the same dimensions, have higher fatigue resistance.

NEW ROTO-FLO ROLLED SPLINES

A new "chipless" machining process, ROTO-FLO spline rolling, offers a lower-cost method to the design engineer for producing splines, serrations, and similar accurate toothed parts.

Extremely accurate, as well as low cost, the splines may be formed on a shaft, even right next to a shoulder. Helical, straight or taper splines are formed in as little as ten seconds, which is up to thirty times faster than other methods.

Shown are some of the splines that ROTO-FLO spline rollers have formed in a wide variety of metals. Fine pitch standard splines formed by this method deliver maximum torque, are easy to assemble, may even permit savings in material. Splines may be heat-treated the same as splines produced by other methods.

Request ROTO-FLO bulletin RF-54 for additional information.

MICHIGAN TOOL Company

complete from blank to finished gear equipment

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IN CANADA: COLONIAL TOOL CO., LTD., WINDSOR, ONTARIO

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. . . and do they bound from your cranium with a purpose? Then you're the Mechanical Engineer we're looking for at Firestone—a man with real scope who wants to work in a creative climate.

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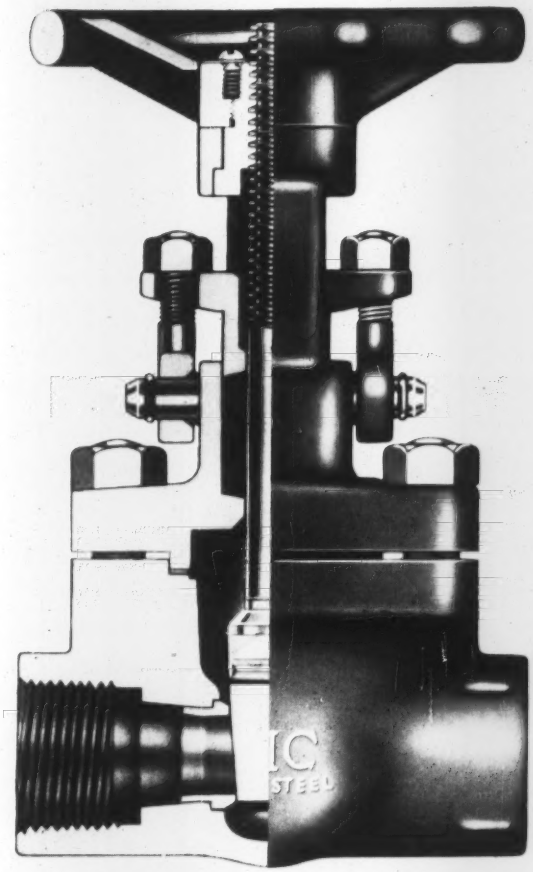
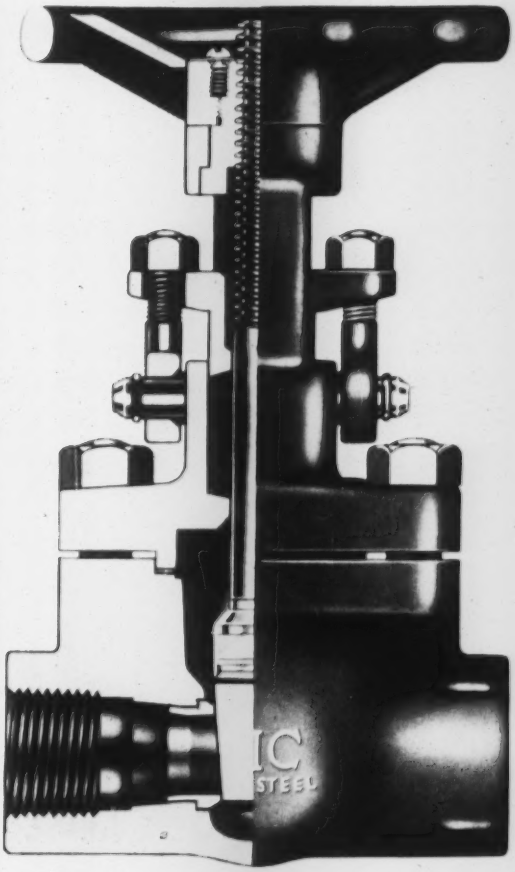
1100 LINE

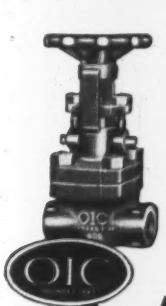


1300 LINE



New, OIC bolted bonnet, 600 lb. forged steel gate valve lines, ½" to 2" with HCH, all purpose trim.

2 new rugged OIC forged steel lines



Both feature the modern and rugged bolted bonnet joint, which simplifies and lowers the cost of maintenance.

Both feature a soft iron gasket securely retained in the bolted male and female body-bonnet connection to assure enduring tightness.

Both feature 13% chrome stainless steel trim with 1000 Brinell, duracased wedges.

Both feature plenty of gripping area for pipe wrenches on pipe ends; there's no interference with body-bonnet flanges. Simplifies joint make-up!

The 1300 line includes a *high flow* port area, offering full-flow characteristics.

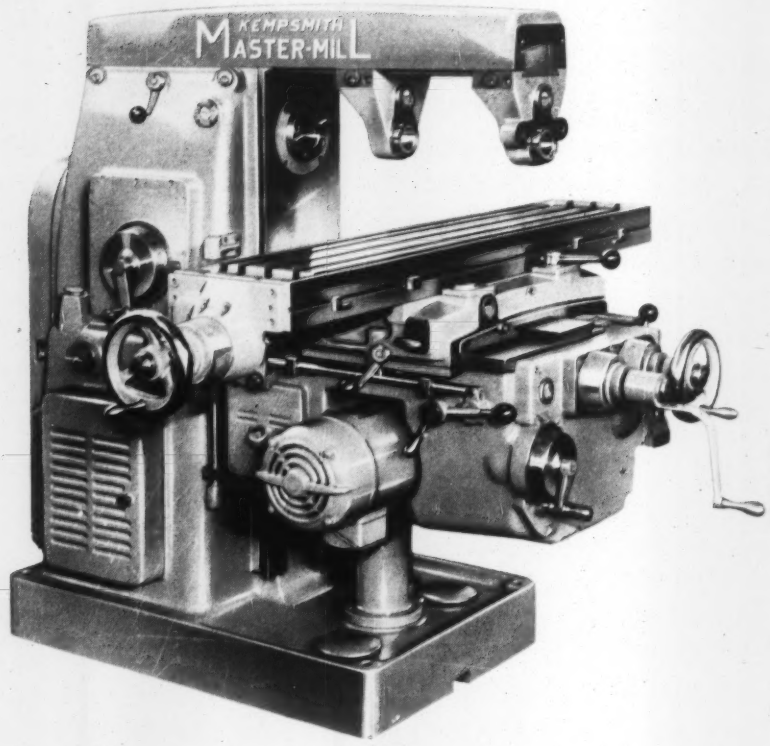
The 1100 line, with standard flow ports, is compact, economical, and includes the same high quality, rugged features and trim as the 1300 line.

Most valve users have applications suited to both of these new OIC valve lines. Write for Bulletin *#195-R* illustrating features and specifications that fit these newest forged steel valves to your services.

THE OHIO INJECTOR COMPANY • WADSWORTH, OHIO

VALVES | **FORGED & CAST STEEL, LUBRICATED PLUG, BRONZE & IRON VALVES**

New! Completely redesigned milling machine switches spindle to TIMKEN® bearings



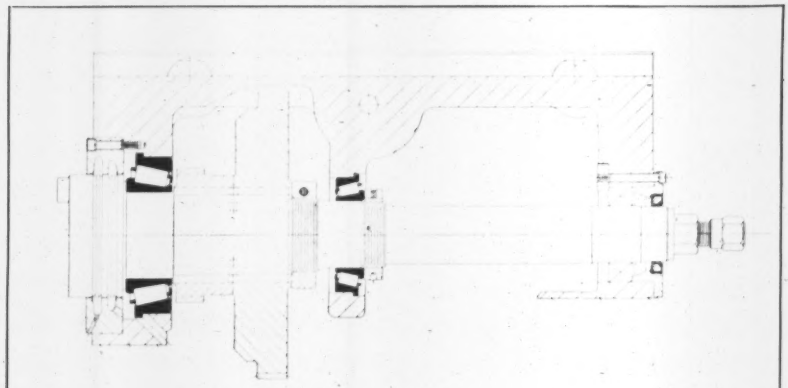
THIS Kempsmith Master-Mill, made by Kempsmith Machine Company, is a brand new, improved model—designed to meet new demands for higher production, lower milling costs. Kempsmith switched to Timken® tapered roller bearings on the new Kempsmith Master-Mill to offer users their many advantages on the spindle, on the table leadscrew, on elevating pinion, and cross feed screw.

Kempsmith reports that Timken bearings are easier to install and adjust, have greater load capacity in small space, are much easier to preload.

Timken bearings hold the spindle in rigid alignment, meeting the requirement of "zero end play over a 24 to 1500 rpm speed range". Tapered construction lets Timken bearings take the radial and thrust loads encountered by a milling machine spindle, in any combination.

Timken bearings were specified, too, because of the heavy shock loads induced by the milling cutter—shocks further amplified by interrupted cuts. Rollers and races in Timken bearings are case-carburized, with tough, shock-resistant cores under hard wear-resistant surfaces. They'll *take* heavy shock loads! And Timken bearings give extra load-carrying capacity with their full line contact between rollers and races.

Geometrically designed for true rolling motion, Timken bearings are precision-manufactured, under rigid quality controls, to conform to their design. We even make our own steel, something no other American bearing maker does. Buying or building machines like this? Look for the trade-mark "TIMKEN" on every bearing! The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".



KEMPSMITH MACHINE COMPANY mounts the spindle of their new Kempsmith Master-Mill milling machine on Timken tapered roller bearings to hold spindle in rigid alignment.

This symbol on a product means its bearings are the best.

TIMKEN

TRADE-MARK REG. U.S. PAT. OFF.

TAPERED ROLLER BEARINGS ROLL THE LOAD